POOR LEGIBILITY

ONE OR MORE PAGES IN THIS DOCUMENT ARE DIFFICULT TO READ
DUE TO THE QUALITY OF THE ORIGINAL

BROWN VANDEVER

PA QUESTIONNAIRE

Name PATRICK MOLLOY Location 35° 21' 02" : 107° 56' 25"

Site Name NAVAJO - BROWN VANDEVER URANIUM MINE Date JUNE, 1990

MAJOR CONSIDERATIONS

A) DOES ANY QUALITATIVE OR QUANTITATIVE INFORMATION EXIST THAT MAY INDICATE AN OBSERVED RELEASE TO AIR, GROUND WATER, SOIL OR SURFACE WATER? YES

Describe: GAMMA RATEMETER READING OF 10^5 cpm ON "HOT ROAD" CONSISTENT WITH Rn^{222} CONCENTRATION OF 10^4 ATOMS PER CUBIC CENTIMETER

B) IF THE ANSWER TO #1 IS YES, IS THERE EVIDENCE OF DRINKING WATER SUPPLY CONTAMINATION OR ANY OTHER TARGET CONTAMINATION (i.e., foodchain, recreation areas, or sensitive environments)? NO

Describe:

C) ARE THERE SENSITIVE ENVIRONMENTS WITHIN A 4-MILE RADIUS OR 15 DOWNSTREAM MILES OF THE SITE? YES IF YES, DESCRIBE IF ANY OF THE FOLLOWING APPLY:

- Multiple sensitive environments? YES

- Federally designated sensitive environment(s)? YES

- Sensitive environment(s) downstream on a small or slow flowing surface water body?

  NO

D) IS THE SITE LOCATED IN AN AREA OF KARST TERRAIN? NO

Describe:

E) IS THE AQUIFER UNDERLYING THE SITE A "SOLE SOURCE" AQUIFER AS DESIGNATED ACCORDING TO SECTION 1424(e) OF THE SAFE DRINKING WATER ACT? NO

Describe:

F) DOES ANY QUALITATIVE OR QUANTITATIVE INFORMATION EXIST THAT PEOPLE LIVE OR ATTEND SCHOOL ON ONSITE CONTAMINATED PROPERTY? YES

Describe: APPROXIMATELY 65 PEOPLE LIVE ON SITE

SITE INFORMATION

SITE NAME: BROWN VANDEVER URANIUM MINE

ADDRESS: FOUR MILES NNE OF BLUEWATER, NEW MEXICO

CITY: BLUEWATER COUNTY: McKINLEY STATE: NM ZIP: 870[illegible]

EPA ID: ** NOT ASSIGNED **

LATITUDE: 35° 21' 02" ; LONGITUDE: 107° 56' 25"

2. DIRECTIONS TO SITE (From nearest public road): FROM ATSF UNDERPASS ON INTERSTATE 40 FRONTAGE ROAD PROCEED E ON IMPROVED DIRT ROAD, TURN N AT APPROXIMATELY 4.5 mi., PROCEED N 1.2 mi., TURN W, GATE WITH HOOK .1 mi., SITE ENVIRONS

3. SITE OWNERSHIP HISTORY (Use additional sheets, if necessary):

A. Name of current owner: VANDEVER OUTFIT/NAVAJO NATION

Address: P. O. BOX 308 (NN)

City: WINDOW ROCK County: APACHE State: AZ Zip: 8651[illegible]

Dates: From 1868 To PRESENT Phone: (602) 871 - 4941

B. Name of previous owner: NO PREVIOUS OWNER

Address: ____

City: ____ County: ____ State: __ Zip: ____

Dates: From ____ To ____ Phone: ____

Source of ownership data: TREATY OF 1868

4. TYPE OF OWNERSHIP (Check all that apply):

___ Private ___ State ___ Municipal

___ Federal ___ County _X_ Other (describe): NAVAJO NATION

NAME OF SITE OPERATOR: NONE: MINING ACTIVITY HAS CEASED

ADDRESS: N/A

CITY: ______ COUNTY: ______ STATE: __ ZIP: ______

PHONE: ______

BACKGROUND/OPERATING HISTORY

6. DESCRIBE OPERATING HISTORY OF SITE: MINE WAS OPENED IN 1952 BY SUTTON, THOMPSON AND WILLIAMS: OPERATED IN 1953 BY WILLIAMS: OPERATED IN 1955 BY SANTA FE URANIUM: OPERATED IN 1955 - 1956 BY SANTA FE URANIUM AND FEDERAL URANIUM: OPERATED IN 1957 - 195 BY FEDERAL URANIUM: OPERATED IN 1963 - 1964 BY MESA MINING CO.: OPERATED IN 1966 BY CIBOLA MINING CO.

   Source of information: REFERENCE # 2

7. DESCRIBE SITE AND NATURE OF SITE OPERATIONS (property size, manufacturing, waste disposal, storage, etc.): SITE IS LOCATED AT THE SOUTHEASTERN MARGIN OF HAYSTACK MOUNTAIN IN A RURAL SHEEP RAISING AREA. SITE IS COMPRISED OF APPROXIMATELY ¼ SECTION. INACTIVE URANIUM MINE; MINE SPOILS DISPOSED OF ON SITE; NO BARRICADES OR CONTAINMENT OF SPOILS.

   Source of information: WINDSHIELD SURVEY (REFERENCE # 3)

8. DESCRIBE ANY EMERGENCY OR REMEDIAL ACTIONS THAT HAVE OCCURRED AT THE SITE:

   NONE

   Source of information: MR. BROWN VANDEVER

9. ARE THERE RECORDS OR KNOWLEDGE OF ACCIDENTS OR SPILLS INVOLVING SITE WASTES? NO

   Describe: ______

   Source of information: NONE

10. DISCUSS EXISTING SAMPLING DATA AND BRIEFLY SUMMARIZE DATA QUALITY (e.g., sample objective, age/comparability, analytical methods, detection limits and QA/QC):

RADIATION SURVEY CONDUCTED AT SITE APRIL 11,1990: BACKGROUND TAKEN AT SITE WITH EBERLINE ESP - II IN RATEMETER MODE : DATA TAKEN AT "SHINE" (1 METER ABOVE SURFACE) : RATEMETER UTILIZED SPA - 3 HIGH GAMMA SENSITVITY PROBE: CALIBRATION DATE JAN 5, 1990: DETECTION LIMITS 1200kcpm per $mR.hr^{-1}$ WITH Cs^{137} CALIBRATION SOURCE: QA/QC REPEATABILITY $\simeq \pm$ .003%

Source of information: WINDSHIELD SURVEY, REFERENCE # 15

WASTE CONTAINMENT/HAZARDOUS SUBSTANCE IDENTIFICATION

11. FOR EACH SOURCE AT THE SITE, SUMMARIZE ON TABLE 1 (page 12): 1) Methods of hazardous substance disposal, storage or handling; 2) size/volume/area of all features/structures that might contain hazardous waste/ 3) condition/integrity of each storage disposal feature or structure; and 4) types of hazardous substances handled.

12. BRIEFLY EXPLAIN HOW WASTE QUANTITY WAS ESTIMATED (e.g., historical records or manifests, permit applications, air photo measurements, etc.):

PHOTOGRAPHS, VEHICLE ODOMETER READINGS; GEOMETRIC AND PHYSICAL CONCEPTS

Source of information: WINDSHIELD SURVEY, REFERENCES # 3, #14, #15, # 18

13. DESCRIBE ANY RESTRICTIONS OR BARRIERS ON ACCESSIBILITY TO ONSITE WASTE MATERIALS:

ONE GATE WITH IRON HOOK

Source of information: WINDSHIELD SURVEY

GROUND WATER CHARACTERISTICS

14. ANY POSITIVE OR CIRCUMSTANTIAL EVIDENCE OF A RELEASE TO GROUND WATER? ?

Describe: INDIAN HEALTH SERVICE INSTALLATION OF A COMPLETE WATER SYSTEM FOR THE COMMUNITY; AREA HAS A REPUTATION FOR HAVING RADIOSPECIES-CONTAMINATED WATER SOURCES

Source of information: REFERENCES #19, #21

15. ON TABLE 2 (page 13), GIVE NAMES, DESCRIPTIONS, AND CHARACTERISTICS OF GEOLOGIC/HYDROGEOLOGIC UNITS UNDERLYING THE SITE.

16. NET PRECIPITATION: * MINUS 44 in.*

SURFACE WATER CHARACTERISTICS

17. ARE THERE SURFACE WATER BODIES WITHIN 2 MILES OF THE SITE? YES

X Ditches ____ Lakes ____ Pond

____ Creeks ____ Rivers X Other WASH

18. DISCUSS THE PROBABLE SURFACE RUNOFF PATTERNS FROM THE SITE TO SURFACE WATERS:
FROM THE TAILINGS ASSOCIATED WITH THE INCLINED ADITS, SURFACE WATER RUNOFF FLOWS EASTSOUTHEASTWRD FOR APPROX. 1 mi.; RUNOFF THEN PROCEEDS SOUTHEAST APPROX. 3 mi. BEFORE TERMINATING. FROM THE STRIP MINE TAILINGS SURFACE RUNOFF PROCEEDS OVERLAND APPROX. .7 mi. BEFORE CONVERGING WITH ABOVE DRAINAGE: FLOW IS ENE

19. PROVIDE A SIMPLIFIED SKETCH OF SURFACE RUNOFF AND SURFACE WATER FLOW SYSTEM FOR 15 DOWNSTREAM MILES (see item #36).

20. ANY POSITIVE OR CIRCUMSTANTIAL EVIDENCE OF SURFACE WATER CONTAMINATION? YES

Describe: RADIATION SURVEY RESULTS CONSISTENT WITH RADIOSPECIES MIGRATION INTO SOUTHEAST TRENDING DRAINAGE: READINGS WERE 10 - 15 TIMES BACKGROUND.

Source of information: WINDSHIELD SURVEY, FIELD NOTES(REF'S.#14,#18)

21. ESTIMATE THE SIZE OF THE UPGRADIENT DRAINAGE AREA FROM THE SITE: 73.4 acres

Source of information: REFERENCES #3, #4;WORKSHEET#1,#7

22. DETERMINE THE AVERAGE ANNUAL STREAM FLOW OF DOWNSTREAM SURFACE WATERS

Water body: RIO SAN JOSE Flow: 2.97 cfs

Water body: ____ Flow: ____ cfs

Water body: ____ Flow: ____ cfs

Source of information: REFERENCE#20

23. IS THE SITE OR PORTIONS THEREOF LOCATED IN SURFACE WATER? NO

24. IS THE SITE LOCATED IN A FLOODPLAIN (indicate flood frequency)? ?

25. IDENTIFY AND LOCATE (see item #36) ANY SURFACE WATER RECREATION AREA WITHIN 15 DOWNSTREAM MILES OF THE SITE: NONE

Source of information: REFERENCE # 16

26. TWO YEAR 24-HOUR RAINFALL: 1.26 in.

TARGETS

27. DISCUSS GROUND WATER USAGE WITHIN FOUR MILES OF THE SITE: AN INDIAN HEALTH SERVICE WATER SYSTEM, WHICH HAS BEEN TURNED OVER TO THE NAVAJO NATION WATER RESOURCES DIVISION (NNWRD), SERVES APPROXIMATELY 430 PERSONS IN THE HAYSTACK COMMUNITY: IT IS ESTIMATED THAT APPROXIMATELY 100 PERSONS TOO INDIGENT TO AFFORD PLUMBING FOR THEIR RESIDENCES UTILIZE OTHER NNWRD WELLS IN THE AREA WHICH ARE SOURCED BY UNCONFINED ALLUVIAL UNIT AND THE DAKOTA SANDSTONE AQUIFER.

Source of information: REFERENCES # 3, 14, 18, 19, 21

28. SUMMARIZE THE POPULATION SERVED BY GROUND WATER ON THE TABLE BELOW:

Distance (miles)	Population
>0 - 1/4	65 est.
>1/4 - 1/2	0
>1/2 - 1	77
>1 - 2	180
>2 - 3	133
>3 - 4	46

Source of information: REFERENCES #4; WORKSHEET#2,7,21

29. IDENTIFY AND LOCATE (see item #36) POPULATION SERVED BY SURFACE WATER INTAKES WITHIN 15 DOWNSTREAM MILES OF THE SITE: NONE

Source of information: REFERENCES#14,18

30. DESCRIBE AND LOCATE FISHERIES WITHIN 15 DOWNSTREAM MILES OF THE SITE (i.e., provide standing crop or production and acreage, etc.):

NONE

Source of information: REFERENCE#16

31. IF SURFACE WATER RECREATION AREAS EXIST, CHOOSE RECREATIONAL USE CATEGORY, AND THEN DETERMINE THE POPULATION WITHIN THE ASSIGNED RADIUS FROM THE RECREATION AREA. (Use GEMS to allocate into distance rings).

*** NOT APLICABLE ***

a. Capital use and access improvements ______(assigned radius=125 miles)
b. Access improvements only ______(assigned radius=80 miles)
c. Observed use only ______(assigned radius=40 miles)
d. None of the above apply and access is not restricted ______ (assigned radius=10 miles)

Distance (miles)	Population
>0 - 5	
>5 - 10	
>10 - 20	
>20 - 40	
>40 - 60	
>60 - 80	
>80 - 100	
>100 - 125	

32. DETERMINE THE DISTANCE FROM THE SITE TO THE NEAREST OF EACH OF THE FOLLOWING LAND USES.

Description	Distance (miles)
Commercial/Industrial/ Institutional	GT.4 mi.
Single Family Residential	0 mi.
Multi-Family Residential	0 mi.
Park	GT.4 mi.
Agricultural	0 mi.

Source of information: WINDSHIELD SURVEY

33. SUMMARIZE THE POPULATION WITHIN A FOUR-MILE RADIUS OF THE SITE:

Distance (miles)	Population
onsite	65
>0 - 1/4	65
>1/4 - 1/2	0
>1/2 - 1	93
>1 - 2	197
>2 - 3	149
>3 - 4	62

Source of information: REFERENCES#4; WORKSHEET#2,7,21

OTHER REGULATORY INVOLVEMENT

34. DISCUSS ANY PERMITS/VIOLATIONS:

County: __________

State: __________

Federal: __________

Other: NAVAJO NATION

Source of information: REFERENCE#17

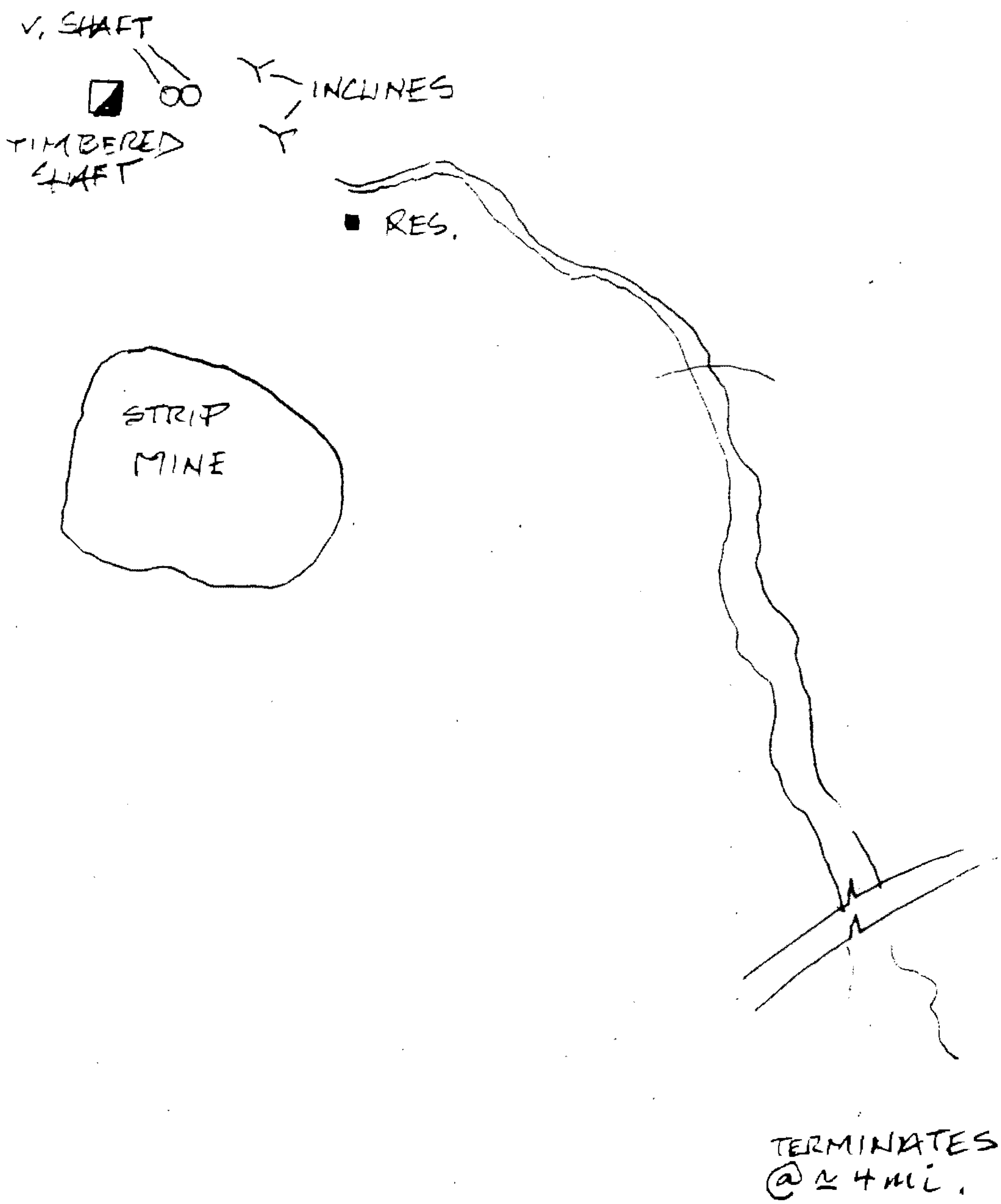
35. SKETCH OF SITE

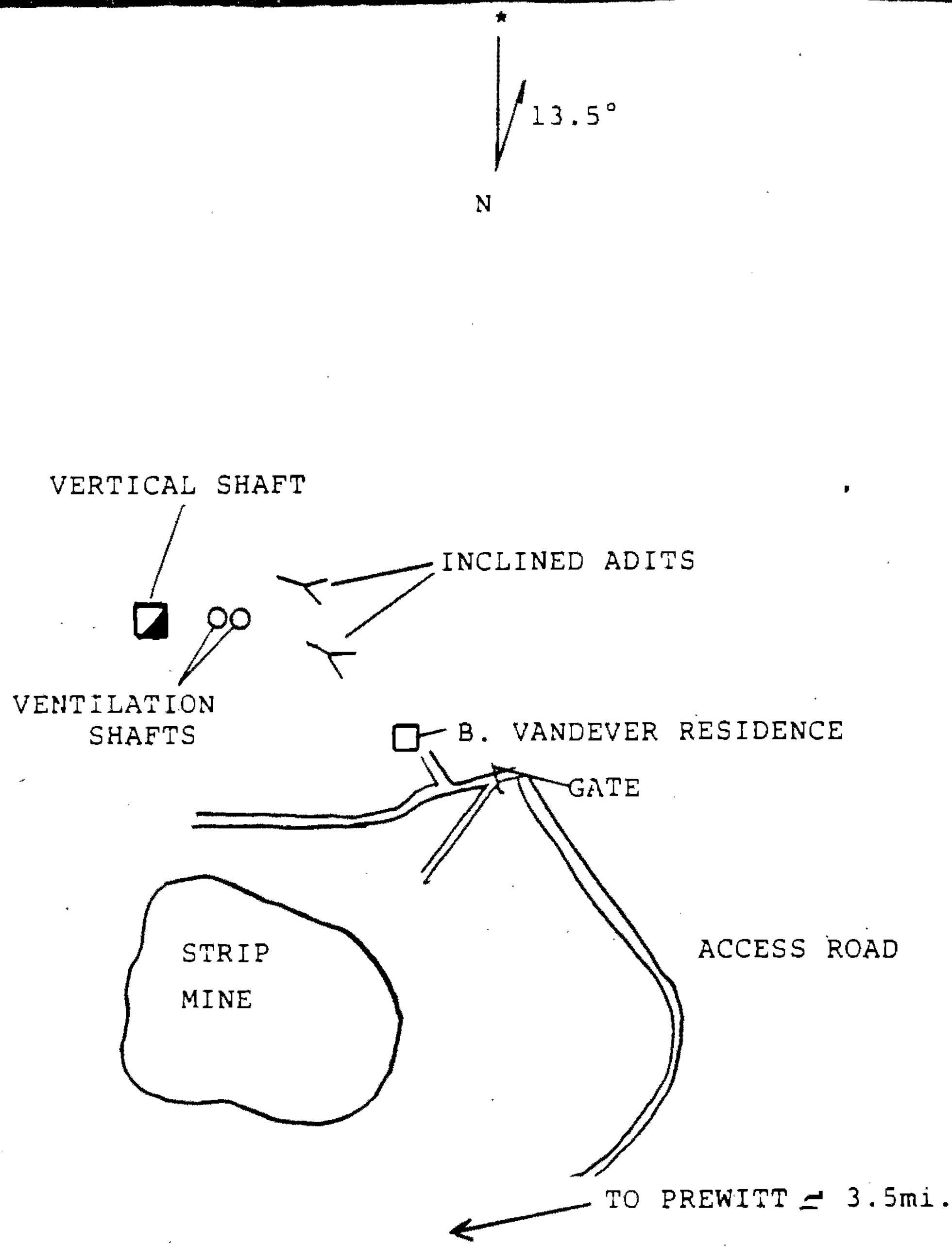
Include all pertinent features, e.g., wells, storage areas, underground storage tanks, waste areas, buildings, access roads, areas of ponded water, etc. Attach additional sheets with sketches of enlarged areas, if necessary.

*** SEE ATTACHED ***

36. <u>SURFACE WATER FEATURES</u>

Provide a simplified sketch of surface runoff and surface water flow system for 15 downstream miles. Include all pertinent features, e.g., intakes, recreation areas, fisheries, gauging stations, etc.





SCALE - 1" ≃ 1418 ft.

NAVAJO SUPERFUND OFFICE

NAVAJO-BROWN VANDEVER URANIUM MINE SITE SKETCH

JUNE, '90 P. MOLLOY

WASTE CONTAINMENT AND HAZARDOUS SUBSTANCE IDENTIFICATION[1]

SOURCE TYPE	SIZE (Volume/Area)	ESTIMATED WASTE QUANTITY	SPECIFIC COMPOUNDS	CONTAINMENT[2]	SOURCE OF INFORMATION
Adits, Shafts	7.02 Acres	Unknown	U_3O_8, V_2O_5, Radon	None	Ref's # 3,4,14
Tailings Piles	125 acres	1880.3 tons	U_3O_8, V_2O_5, Radon	None	Ref's # 3,4,14

1 Use additional sheets if necessary

2 Evaluate containment of each source from the perspective of each migration pathway (e.g., ground water pathway - nonexistent, natural or synthetic liner, corroding underground storage tank; surface water - inadequate freeboard, corroding bulk tanks; air - unstabilized slag piles, leaking drums, etc.)

TABLE 2
HYDROGEOLOGIC INFORMATION[1]

STRATA NAME/DESCRIPTION	THICKNESS (ft.)	DEPTH TO WATER (ft.)	HYDRAULIC CONDUCTIVITY (cm/sec)	TYPE OF DISCONTINUITY[2]	SOURCE OF INFORMATION
Entrada SS (Je) Sandstone, Reddish orange, poor aquifer, mapped with wingate sandstone in this area (Trw)	0-50	N/A	10^{-3} to 10^{-5}	None	Ref's # 3,5, 6, 8
Chinle formation (Trc) red beds, shale, siltstone. Sonsela sandstone is fair to good aquifer: water brackish	1600	150	10^{-3} to 10^{-5}	None	"
Shinarump conglomerate (Trcs) sand-stone - conglomerate-mudstone, orange to purple. Comprises an aquifer in some regions.	100	1950	10^{-3} to 10^{-5}	"	"
Moenkopi formation (Trm) siltstone and sandstone, red to white	50	N/A	"	"	"
San Andres LS (Psa) dolomitic Limestone. Excellent aquifer north, east and west of Zuni Mountains.	100	1900	"	"	"

1 Use additional sheets if necessary

2 Identify the type of discontinuity within four-miles from the site (e.g., river, strata "pinches out", etc.)

REFERENCE # 1

NAVAJO SUPERFUND OFFICE

BROWN VANDEVER URANIUM MINE REFERENCE MATERIAL

MAY, '90 P. MOLLOY

EPA POTENTIAL HAZARDOUS WASTE SITE IDENTIFICATION

REGION	SITE NUMBER
VI	

NOTE: The initial identification of a potential site or incident should not be interpreted as a finding of illegal activity or confirmation that an actual health or environmental threat exists. All identified sites will be assessed under the EPA's Hazardous Waste Site Enforcement and Response System to determine if a hazardous waste problem actually exists.

A. SITE NAME	B. STREET (or other identifier)		
BROWN URANIUM MINES	35° 21' 02" : 107° 56'25"		
C. CITY	**D. STATE**	**E. ZIP CODE**	**F. COUNTY NAME**
PREWITT	NM	87045	MCKINLEY

G. OWNER/OPERATOR (if known)

1. NAME	2. TELEPHONE NUMBER
WILLIAMS AND THOMPSON, BROWN VANDEVER	(UNKNOWN)

H. TYPE OF OWNERSHIP (if known)

☐ 1. FEDERAL ☐ 2. STATE ☐ 3. COUNTY ☐ 4. MUNICIPAL ☒ 5. PRIVATE ☐ 6. UNKNOWN X 7. TRIBAL

I. SITE DESCRIPTION

An abandoned uranium/vanadium mine located approximately 1/4 mile from residence. Site located on ledge of Haystack Mountain. Tailings used to backfill one adit. Open and second adit.

J. HOW IDENTIFIED (i.e., citizen's complaints, OSHA citations, etc.)	K. DATE IDENTIFIED (mo., day, & yr.)
WINDSHIELD SURVEY	01/23/90

L. SUMMARY OF POTENTIAL OR KNOWN PROBLEM

Maximum reading of 400 $uR^{\cdot -1}$ on North tailings pile by adit. Tailings spilled into drainage southeast of north adit. Adits presently used as trash dumping areas.

M. PREPARER INFORMATION

1. NAME	2. TELEPHONE NUMBER	3. DATE (mo., day, & yr.)
PATRICK MOLLOY, NAVAJO SUPERFUND OFFICE	602/871-3153	Feb. 26, 1990

EPA Form 2070-8 (5-80)

REFERENCE #2

NAVAJO SUPERFUND OFFICE

BROWN VANDEVER URANIUM MINE REFERENCE MATERIAL

MAY, '90 P. MOLLOY

O.F.R.
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OPEN-FILE REPORT

NAVAJO SUPERFUND OFFICE

This report is preliminary and has not been edited or reviewed for conformity to New Mexico Bureau of Mines standards

Number	Mine Name	Tons Ore	Pounds U_3O_8	% U_3O_8	Pounds V_2O_5	% V_2O_5	Type of Deposit	Host Rock	Periods of Production/ Shipper
13N.9W.20.321	Mesa Top Mine	108,261	512,965	0.24	144,610	—	sandstone	Jmp	1954-1957 - Lea Explor 1957-Holly Minerals a
13N.10W.4.244	Pat - Section 4 (Dakota Mine)	5,069	12,645	0.12	2,478	—	sandstone	Jmw, Kd	1952-1959 - Dakota Min. Co.; 1962-1963-Farris Mines, Inc.
13N.9W.19.420	[1]Poison Canyon	217,066	1,004,574	0.23	338,094	—	sandstone	Jmp	1952-1959 - Haystack M Development Corp.; 19 1962-Farris Mines Inc
14N.11W.28.113	Red Cap Group (T Group)	195	497	0.13	951	0.24	limestone	Jt	1952-1953 - Navajo Dev ment Co.; 1953-Fitzhu Doerrie
13N.10W.16.134	Red Point Lode	482	1,223	0.13	746	0.07	limestone	Jt	1952-1955 - R.M. Shaw
14N.11W.20.144	Red Top Mines	165	390	0.12	1,287	0.39	limestone	Jt	1955 - Red Top Uranium Mining Co.
14N.9W.34.424	[1]Sandstone	1,034,255	3,540,829	0.17	—	—	sandstone	Jmw	1959-1963 - Phillips Petroleum Co.; 1963-19 United Nuclear Corp.
13N.9W.1.200	[1]Section 1 (13N-9W) mined through Cliffside	148,066	1,699,137	0.57	—	—	sandstone	Jmw	1967 - Kerr-McGee; 1969 Kerr-McGee and Nation
15N.16W.3.332	Section 3 (15N-16W) Santa Fe-Christensen Rats Nest Mine	324	1,836	0.28	404	—	sandstone (coal)	Kd	1957 - Christensen and Uranium Co.; 1957-1958 Uranium Co.
13N.10W.5.144	Section 5 (13N-10W)	23	54	0.12	—	—	sandstone	Kd	1958 - Westvaco
13N.9W.8.114	Section 8 (13N-9W) Spencer Shaft	47,800	165,319	0.17	—	—	sandstone	Jmp	1958-1960 - United West 1961-Hyde and Casper; 1966-W.D. Tripp; 1966-James J. Goode
14N.10W.10.244	[1]Section 10 (14N-10W)	130,767	510,935	0.20	—	—	sandstone	Jmw	1957-1962 - Kermac Nucl 1964-Homestake-Sapin
14N.10W.12.411	[1]Section 12 (14N-10W)	74,975	211,873	0.14	—	—	sandstone	Jmw	1961 - Anderson Develop Corp.; 1962-1963-Stall Dysart
14N.10W.15.441	[1]Section 15 (14N-10W)	1,213,814	3,625,924	0.15	—	—	sandstone	Jmw	1958-1961 - Homestake-S 1961-1965-Rio and Homestake-Sapin; 1966-1969-Homestake-Sapin; 1969- United Nuclear-Homestak
14N.9W.17.323	[1]Section 17 (14N-9W)	544,164	2,315,182	0.21	—	—	sandstone	Jmw	1960-1964 - Kermac Nucle Corp.; 1965-1970-Kerr-M
13N.10W.18.341	Section 18 (13N-10W) (Indian Allotment) BI. ✓	25,796	98,175	0.19	75,342	0.30	limestone	Jt	1952 - Sutton, Thompson, Williams; 1953-Williams 1955-Santa Fe Uranium; 1956-Santa Fe Uranium & Federal Uranium; 1957-1 Federal Uranium; 1963-1 Mesa Mining Co.; 1966-C Mining Co.
14N.9W.18.400	[1]Section 18 (14N-9W) mined through Sec. 17	501,946	1,586,447	0.16	—	—	sandstone	Jmw	1962-1964 - Kermac Nucle 1965-1970-Kerr-McGee
14N.9W.20.114	[1]Section 20 (14N.9W) mined through Sec. 17	486,375	2,223,977	0.23	—	—	sandstone	Jmw	1962 - Kerr-McGee
14N.10W.22.223	[1]Section 22 (14N-10W)	2,189,051	11,605,672	0.18	—	—	sandstone	Jmw	1958-1964 - Kermac Nucle 1965-1970-Kerr-McGee
	heap leach	—	38,105	—	—	—			
14N.10W.23.134	[1]Section 23 (14N-10W)	2,528,797	9,679,773	0.19	—	—	sandstone	Jmw	1959-1968 - Homestake-Sa 1969-1970-Homestake-Uni Nuclear
13N.10W.23.444	Section 23 (13N-10W)	21,826	138,541	0.32	10,256	0.06	limestone	Jt	1957-1965 - Haystack Mou Development Corp.; 1965 1966-Santa Fe Pacific
13N.9W.24.121	Section 24 (13N-9W) Chill Willis, Rialto (Section 13)	10,950	37,693	0.17	—	—	sandstone	Jmp	1960-1963 - Febco Mines,
13N.11W.24.222	Section 24 (13N-11W) Indian Allotment to Nana-A-Bah Vandever ✓	24,638	115,075	0.22	85,545	0.18	limestone	Jt	1952-1954 - Glen William 1955-1956-Santa Fe Uran 1955-Federal Uranium Co Santa Fe Uranium; 1956- Federal Uranium Corp.
14N.10W.24.332	[1]Section 24 (14N-10W)	1,904,582	7,071,564	0.19	—	—	sandstone	Jmw	1959-1964 - Kerr-McGee Nuclear; 1965-1970-Kerr-McGee
	Heap leach	—	579	—	—	—			
13N.10W.25.411	[1]Section 25 (13N-10W)	235,156	958,058	0.20	153,657	0.12	limestone	Jt	1952 - A T and SF RR; 19 1961-Haystack Mountain D velopment Corp.; 1962-19 Santa Fe Pacific; 1963- Farris Mines, Inc.; 196 1965-Santa Fe Pacific; 1966-Farris Mines, Inc. 1968-Homestake; 1969-19 United Nuclear Corp.
14N.10W.25.144	[1]Section 25 (14N-10W)	1,791,048	6,444,889	0.18	—	—	sandstone	Jmw	1959-1969 - Homestake-Sa 1969-1970-Homestake-Uni Nuclear
13N.10W.26.221	[1]Section 26 (13N-10W) Deeldero Group	11,110	83,752	0.38	17,518	0.08	limestone	Jt	1952-1957 - Hanosh Mines
14N.10W.26.220	[1]Section 26 (14N-10W) mined through Section 24	362,110	1,198,696	0.17	—	—	sandstone	Jmw	1965-1970 - Kerr-McGee

McKinley County

Occurrence Number	Property Name (Occurrence Name)	PRR Number (year)	Classification	Host	Ref.
———	Airbourne Anomaly 11N/15W/23	ED-R-426 (1954)	none	-	1
14N.13W.12.333	Alpha	ED-R-680 (1956)	Shale/Sandstone	Km,Jm	2(
14N.11W.10.340	Bottoms Claims (Red Top #1 and #2)	CEB-18 (1950)	Limestone	Jt	1
16N.18W.26.220	Car Ball #13	ED-R-240 (1953)	Shale	Kc	3
15N.16W.4.414	Claim (U Mine)	ED-R-234 (1953)	Sandstone	Kd	3
13N.10W.4.244	Dakota Mining Co. (pat-Sec.4)	GJEB-R-188 (1952);	Sandstone	Jmw	3
15N.17W.33.244	Diamond #2	unnumbered (1953)	Sandstone	Kd	3
14N.10W.11.312	Dysart #1	NM-101 (1955)	Sandstone	Jmw	1
14N.12W.24.24	Elkins Claims	CEB-17 (1950); GJEB (1950)	Limestone	Jt	3
14N.11W.20.133	Grover Claims	CEB-21 (1950); GJEB (1950)	Limestone	Jt	1
14N.9W.4	Green Pick #20, 21	DEB-252 (1952)	Sandstone	Kp	3
13N.10W.16.100	Hard-word, Red Point, and others	CEB-15 (1950); GJEB (1950)	Limestone	Jt	1
15N.18W.12.244	Hogback No. 4	GJEB:R-173 (1952)	Sandstone/Shale	Kd	1
14N.14W.2.123	Last Chance #2	DEB-248 (1951)	Sandstone	Jmr	1
19N.6W.13,14;19N.6W., 23.344; 19N.6W.25,26	L.L. Farr Ranch (Farr Ranch)	ED-R-450 (1955)	Sandstone Beach placer	Kpc	1
13N.10W.25.411	Operation Haystack-Sec.25 (Sec.25-SEQ-Desidario)	unnumbered (1956)	Limestone	Jt	3
15N.16W.4.111	Prospect #1 (Foutz #1)	ED-R-214 (1953)	Sandstone	Jmw	3
15N.16W.5.222	Prospect #2 (Foutz #2)	ED-R-215 (1953)	Sandstone	Jmw	3
14N.13W.14.222	Reynolds (June)	unnumbered (1950)	Sandstone	Jmr	3
13N.10W.36.224	Rimrock #1 (Section 36)	CEB-14 (1950); GJEB (1950)	Limestone	Jt	3
14N.10W.31.233	Silver Spur #5 (Silver Spur Pits)	DEB-251 (1952)	Sandstone	Kd	1
18N.14W.35.300	Standury Rock	ED-R-620 (1956)	Sandstone Beach placer	Kp	3
14N.11W.28.113	T Claims #1-4 (Red Cap Group)	CEB-20 (1950); GJEB 1950)	Limestone	Jt	1
14N.13W.8	Tietjon-Lewis #8	DEB-249 (1951)	Sandstone	Jmr	1
13N.9W.29.141	Unknown (Faith)	RR-209 (1951)	Limestone	Jt	2(
13N.10W.10.341	Unknown (Section 10)	CEB-10 (1950); GJEB (1950)	Limestone	Jt	1
———	Unknown	ED-R-426 (1954)	none	-	1
13N.10W.19.110	Unknown (Haystack-Sec.19)	CEB-9 (1950); GJEB (1950)	Limestone	Jt	1
13N.10W.24.222	Unknown (Shirley and Gunther, G.)	RR-202-AEC (1951)	Sandstone	Jmw	1;
13N.10W.25.114	Unknown (Section 25 Open-pit)	CED-8 (1950)	Limestone	Jt	1
13N.10W.26.221	Unknown (Section 26)	CEB-7 (1950)	Limestone	Jt	1
13N.11W.13.314	Unknown (Haystack Sec.13 p.t)	CEB-16 (1950); GJEB (1950)	Limestone	Jt	1
13N.11W.21	Unknown - Prewitt	211-AEC (1951)	Limestone	Jt	2(
14N.10W.31.344	Unknown (Febco)	GJEB-R-172 (1952)	Sandstone	Kd	1
14N.11W.19.414	Unknown - Andrews	CEB-19 (1950); GJEB (1950)	Limestone	Jt	1
9N.17W.4	Unknown - Zuni Indian Reservation	RR-207 (1951)	Orthomagmatic	Ti	1 (Valencia
14N.11W.35.120	Unknown (Last Mine)	DEB-237 (1951); RR-210 AEC (1952)	Sandstone	Kd	2 (
14N.13W.14.114	Unknown (Largo)	RR-200 AED (1951)	Limestone	Jt	2 (
15N.17W.28.114	Unknown (Anomaly)	GJEB-145 (1952)	Sandstone	Jmw	1
15N.17W.33.422	Unknown (Anomaly)	GJEB-144 (1952)	Sandstone	Kd	1
15N.19W.32.432	Weingarten State Lease (Gallup titanium deposit)	ED-R-610 (1956)	Sandstone Beach Placer	Kg	3

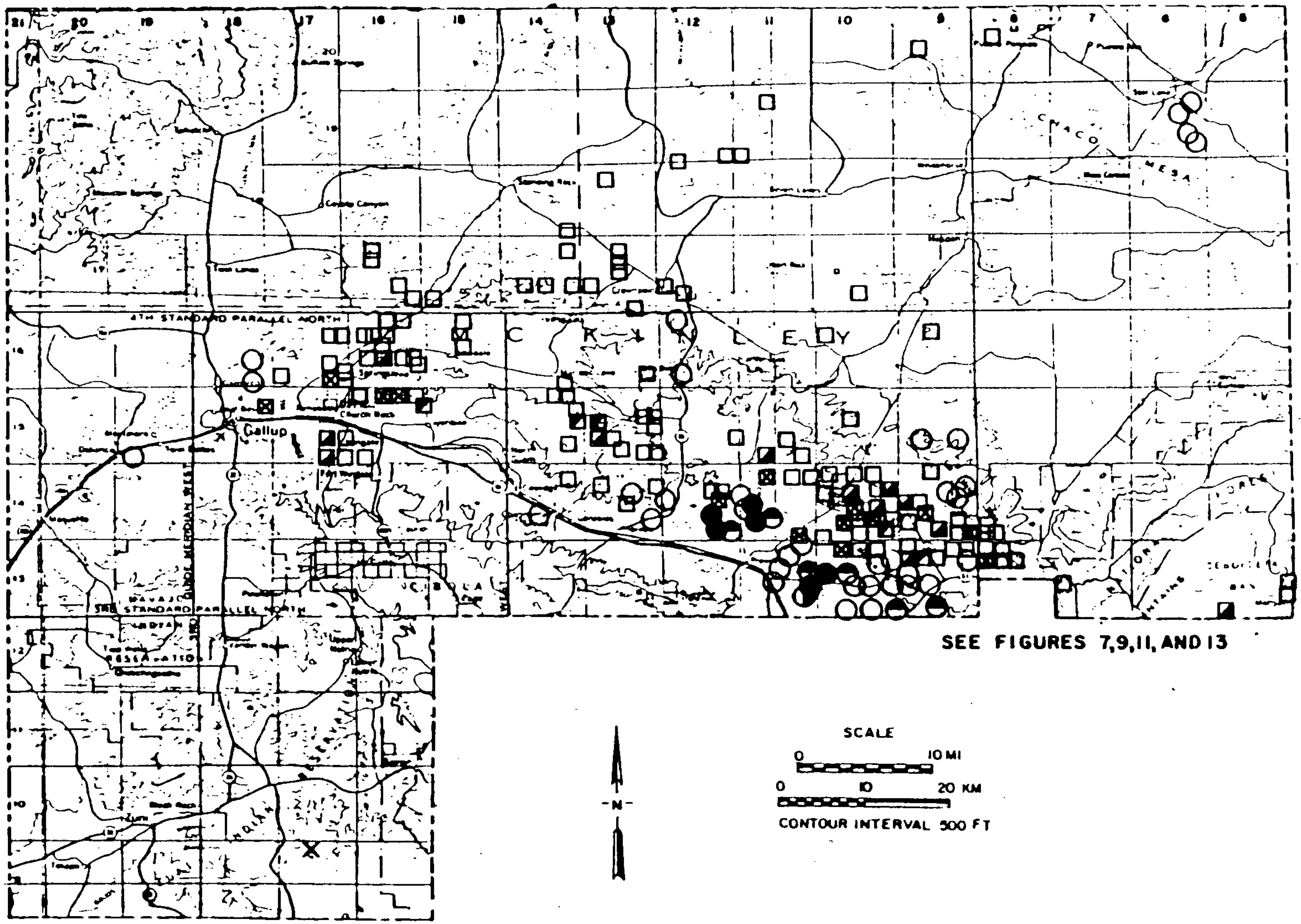
Mora County

Occurrence Number	Property Name (Occurrence Name)	PRR Number (year)	Classification	Host	Ref.
21N.16E.22	A and M Mining	ASO-93 (1955)	Pegmatite	PE	2(p
22N.16E.1	William Atkins	ASO-64 (1955)	Shale/Sandstone	Ps	2(p
22N.16E.13	Le Deoux Ranch	DAO-P-4-1491 (1953)	Sandstone	Ps	2(p
20N.24E.5,19N.23E.1	Sanford Ranch	ASO-65 (1955)	Sandstone	Jm	2(p.
———	Turkey Mountain Area	DEB-RRA-545 (1953)	none	-	3
22N.17E.,21N.16E	United Development Co.(Coyote Creek Misc.prospects)	ASO-66 (1955)	Sandstone/Shale	Ps	2(p.
22N.17E.,21N.16E	United Development Co.(Coyote Creek Misc.prospects)	ASO-67 (1955)	Sandstone/Shale	Ps	2(p.
———	Unknown	unnumbered (1951)	none	-	3
22N.17E.,21N.16E	Unknown (Coyote Creek Misc. prospects)	D-243 (1951)	Sandstone/Shale	Ps	1
———	Unknown	ED-R-1121 (1950)	none	-	3
22N.16E.9	Unknown (Unknown-Mora Grant)	ED-R-1135 (1953)	Orthomagnetic	PE	1
———	Unknown	ED-R-1136 (1953)	none	-	1
22N.17E.,21N.16E; 22N.16E.13	Unknown (Coyote Creek Misc. prospects) (Le Deoux Ranch Lease)	ED-R-1138 (1953)	Sandstone/Shale; Sandstone	Ps	1
———	Unknown	DEB-RRA-1111 (1953)	none	-	1
———	Unknown	ED-R-1140 (1953)	none	-	3
———	Unknown	DEB-RR-501 (1953)	none	-	3
22N.17E.,21N.16E.	Unknown (Coyote Creek Misc. prospects)	ASO-92 (1955)	Sandstone/Shale	Ps	2(p.
22N.17E.,21N.16E.	Unknown (Coyote Creek Misc. prospects)	D-244 (1951)	Sandstone/Shale	Ps	1
———	Unknown	M-1475 (1954)	none	-	1
———	Unknown (No Location given)	unnumbered (1951)	none	-	1

Otero County

Occurrence Number	Property Name (Occurrence Name)	PRR Number (year)	Classification	Host	Ref.
———	Alice, Nannie Beard and Garnet Mines	DEB-RRA-1104 (1953)	none	-	1
16S.11E.17.234	Courtney Mine	DEB-RRA-1134 (1953)	Sandstone-tabular	Pa	3
16S.11E.17.234	Courtney and Grandview	RG-9-51 (1951)	Sandstone-tabular	Pa	1
16S.11E.30.441	Holmes (East Warnock)	RG-14-51 (1951)	Sandstone-tabular	Pa	1
———	Iron Queen Mine	DEB-RRA-105 (1953)	none	-	1
15S.11E.24.142	Lux #2	ASO-73 (1955)	Sandstone-tabular	Pa	2(p.
———	Muscalero Apache Indian Res.	ASO-28 (1954)	none	-	2(p.
———	Providence Mine	DEB-RR-1103 (1953)	none	-	1

FIGURE 1-19–RADIOACTIVE OCCURRENCES IN McKINLEY COUNTY, NEW MEXICO

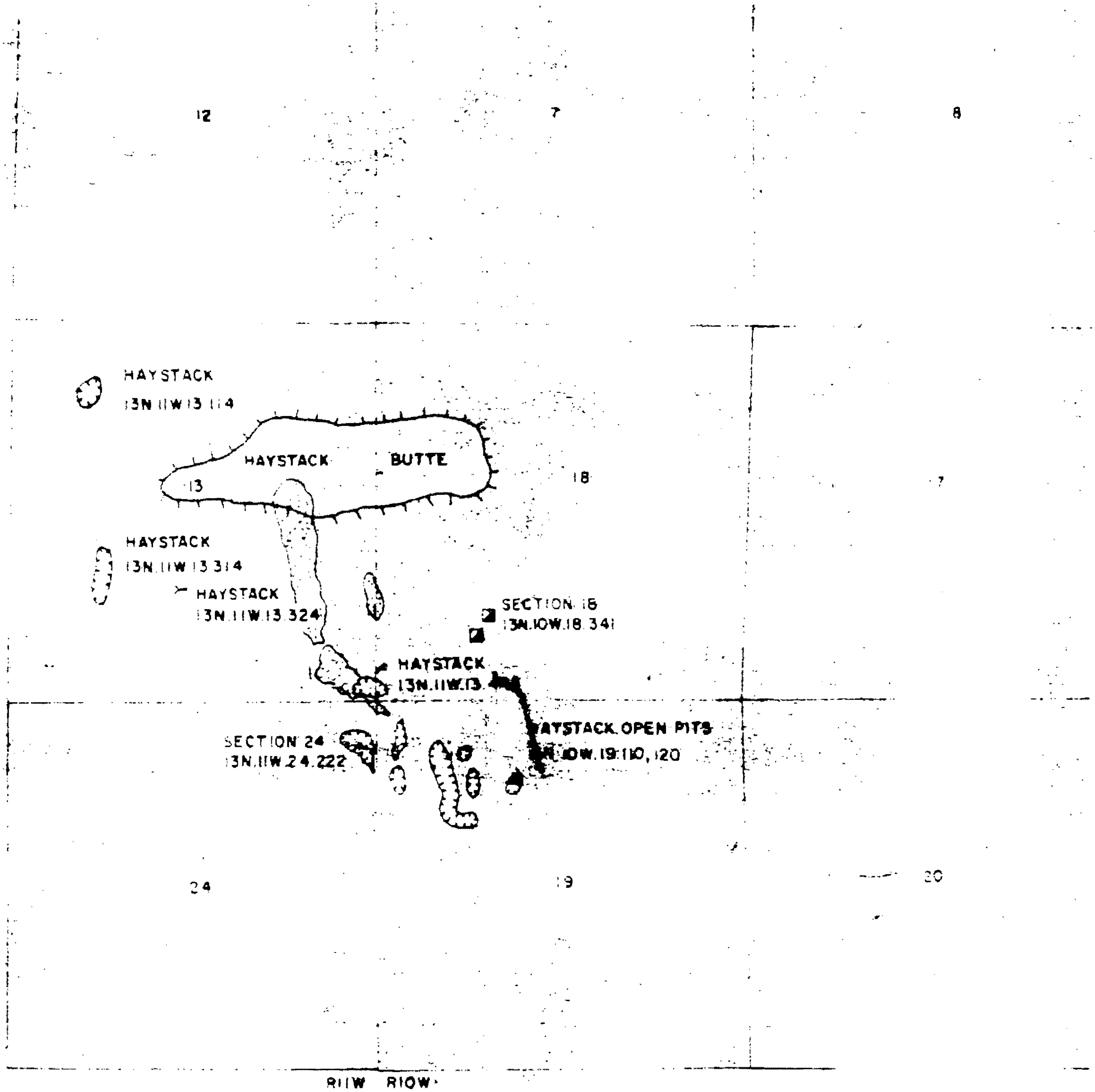


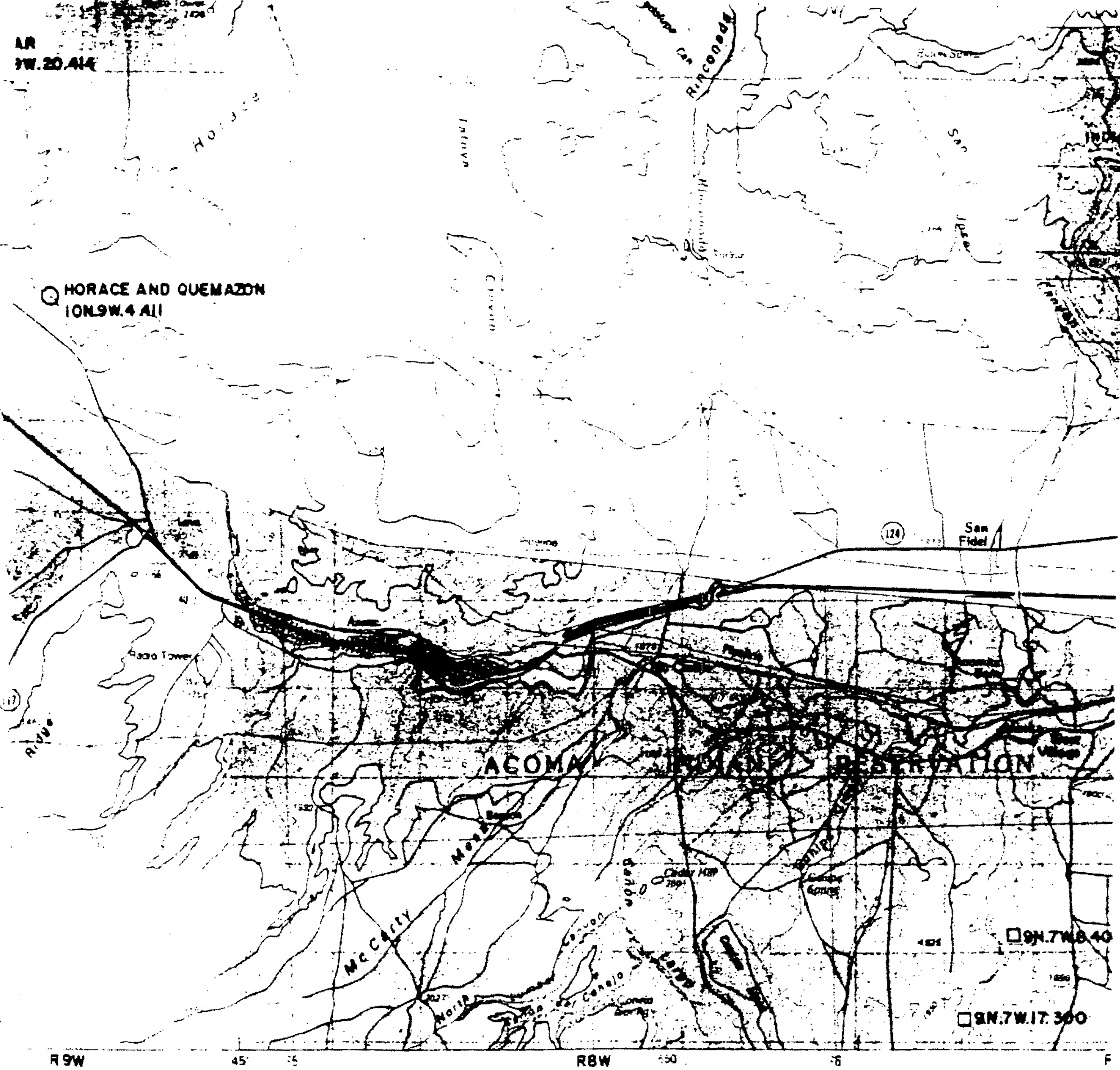
PRODUCTION CATEGORY / CLASS	DEPOSITS IN IGNEOUS AND METAMORPHIC ROCKS	DEPOSITS IN VOLCANIC ROCKS	SANDSTONE DEPOSITS	DEPOSITS IN OTHER SEDIMENTARY ROCKS	DEPOSITS OF UNCERTAIN ORIGIN
OCCURRENCE, NO PRODUCTION	×	△	□	○	◇
UP TO 20,000 POUNDS U_3O_8	⚒	▲	⊠	◓	⬘
20,000 - 200,000 POUNDS U_3O_8	⊗		◩	◑	◆
200,000 - 2 MILLION POUNDS U_3O_8			◪	●	
2 MILLION - 20 MILLION POUNDS U_3O_8			▣		
GREATER THAN 20 MILLION POUNDS U_3O_8			⊟		

TABLE I-1 - KEY TO SYMBOLS USED ON RADIOMETRIC OCCURRENCE LOCATION MAPS

RE 11 -URANIUM ORE DEPOSITS AND MINES IN THE AMBROSIA LAKE SUBDISTRICT, GRANTS URANIUM DISTRICT, MCKINLEY AND CIBOLA COUNTIES, NEW MEXICO.

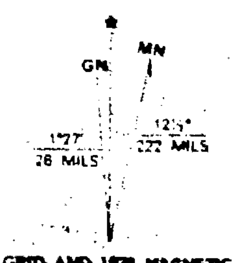
COMPILED BY V.T. MCLEMORE FROM FIELD RECONNAISSANCE (1980 -1982), U.S. ATOMIC ENERGY COMMISSION UNPUBLISHED DATA, NMBMMR UNPUBLISHED DATA, CHAPMAN , WOOD, AND GRISWOLD, INC. (1979), SMITH AND PETERSON (1980), HAZLETT AND KREEK ([illegible]), SQUYRES (1963), THADEN AND SANTOS (1963), AND CLARY AND OTHERS (1963). (THIS MAP IS COMPILED FROM THE BEST DATA AVAILABLE.)


12
7
8
HAYSTACK
13N 11W 13 114
HAYSTACK BUTTE
13
18
7
HAYSTACK
13N 11W 13 314
HAYSTACK
13N 11W 13 324
SECTION 18
13N 10W 18 341
HAYSTACK
13N 11W 13
AYSTACK OPEN PITS
10W 19 110, 120
SECTION 24
13N 11W 24 222
24
19
20
R11W R10W



P INDEX

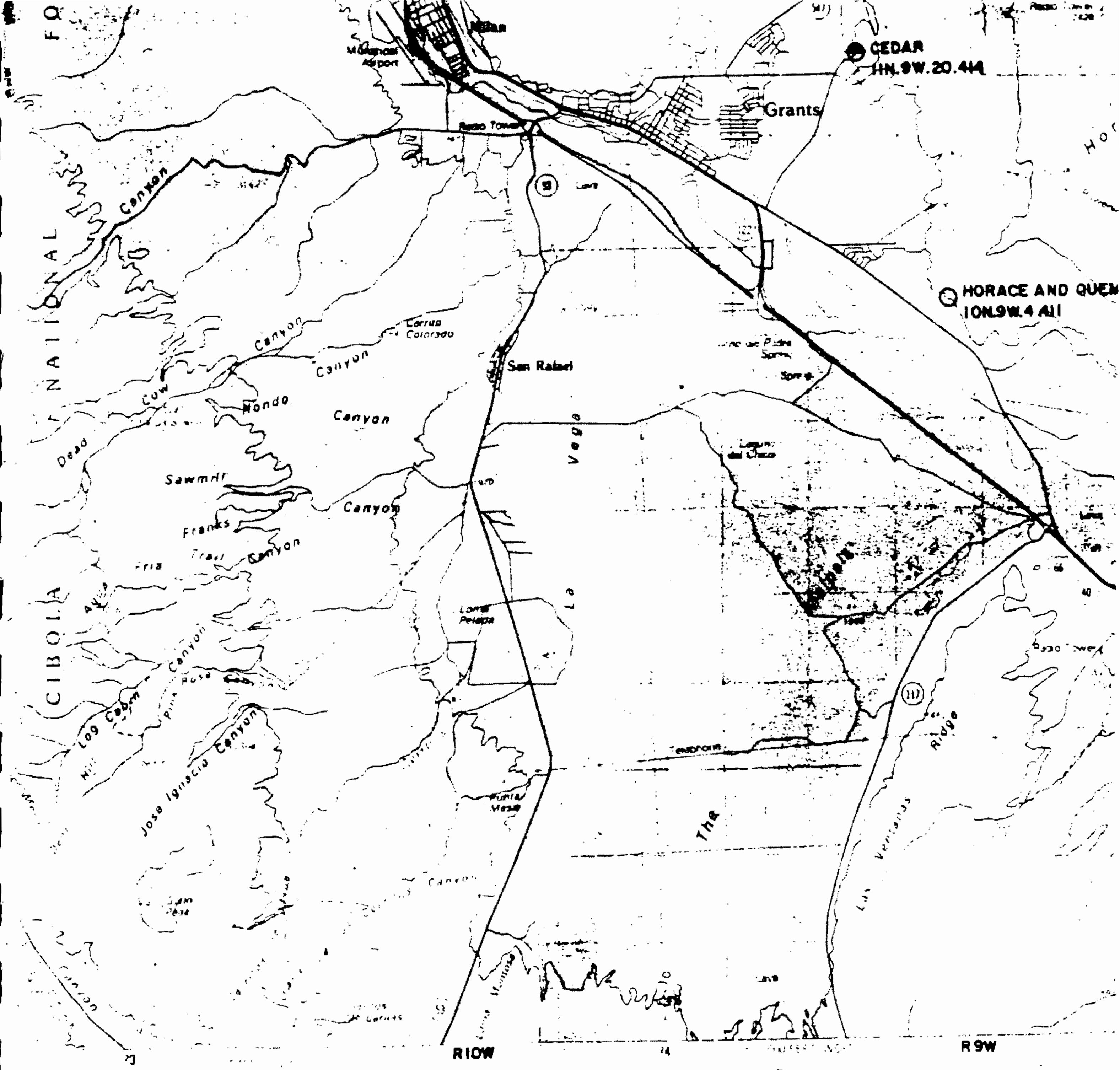
7	Cerro Pinao–1961	24	Herrera–1954
8	Casa Salazar–1961	25	San Rafael–1957
9	Bluewater–1957 (Photorevised–1971)	26	Grants SE–1957 (Photorevised–1971)
10	Dos Lomas–1957	27	Mc Carty–1957 (Photorevised–1971)
11	San Mateo–1963	28	Cubero–1957 (Photorevised–1971)
12	Cerro Pelon–1963		Laguna–1957 (Photorevised–1971)
13	Laguna Cacique–1961		Mesita–1957 (Photorevised–1971)
16	La Gotera–1961		Mesa Gigante–1960
17	Milan–1957 (Photorevised–1971)		Correo School–1964 (Photorevised–1971)
18	Grants–1957 (Photorevised–1971)		



UTM GRID AND 1978 MAGNETIC NORTH DECLINATION AT CENTER OF MAP

FIGURE 7 - URANIUM MINES, DEPOSITS, AND

AND BERNALILLO COUNTIES, NE

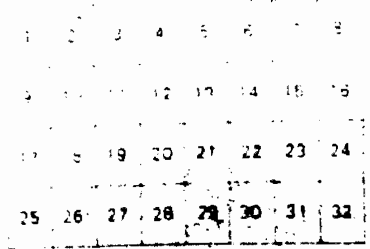


...ited, and published by the Geological Survey

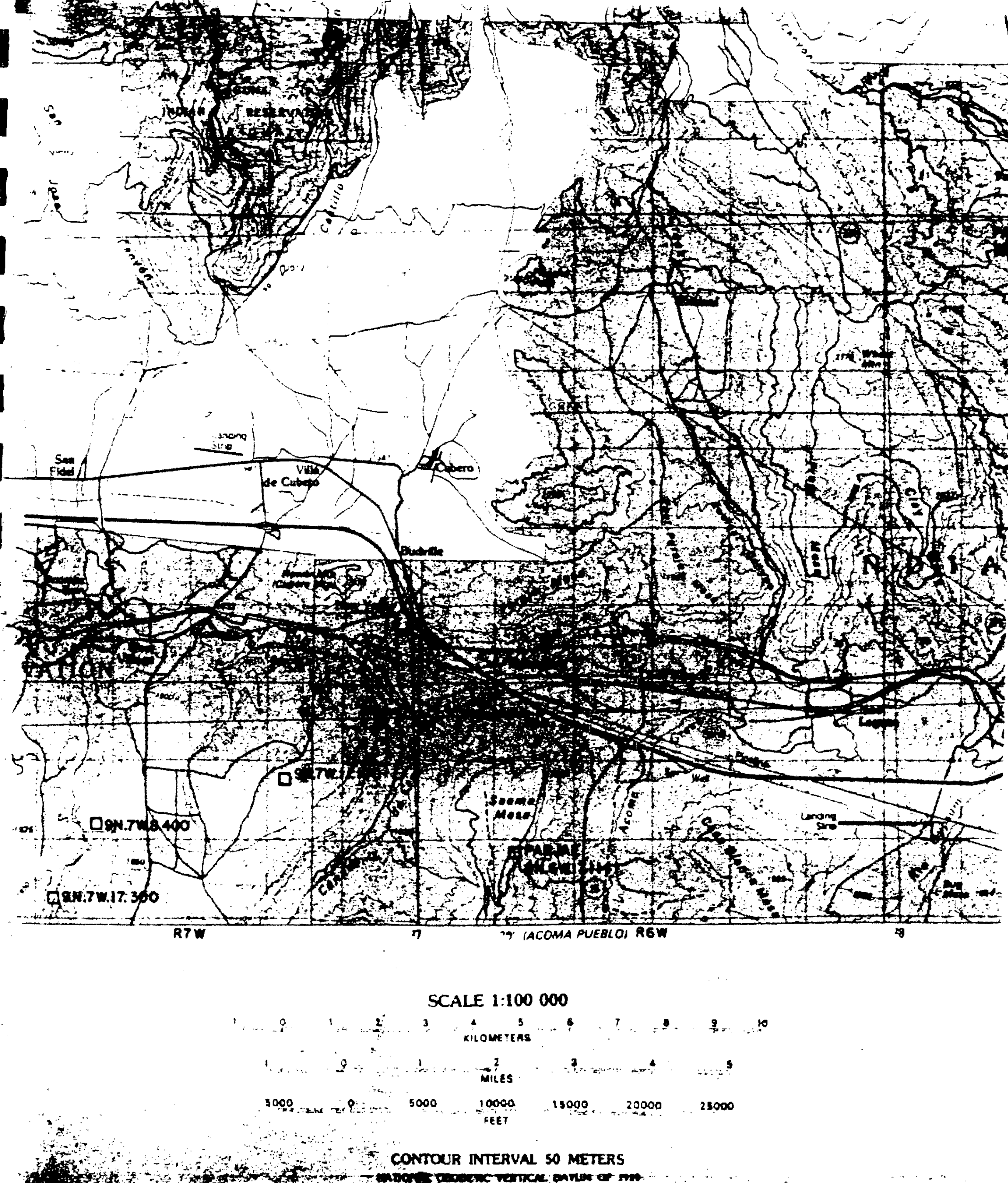
...from USGS 1:24 000 - scale topographic maps
...1963. See index for dates of individual maps
...ed from aerial photographs taken 1973–75 and
...sources. Revised information not field checked
...1978

...10 000 - meter grid, zone 13.
...nsverse Mercator
...t grid ticks based on New Mexico coordinate system
...ral zones. 1927 North American datum

MAP INDEX

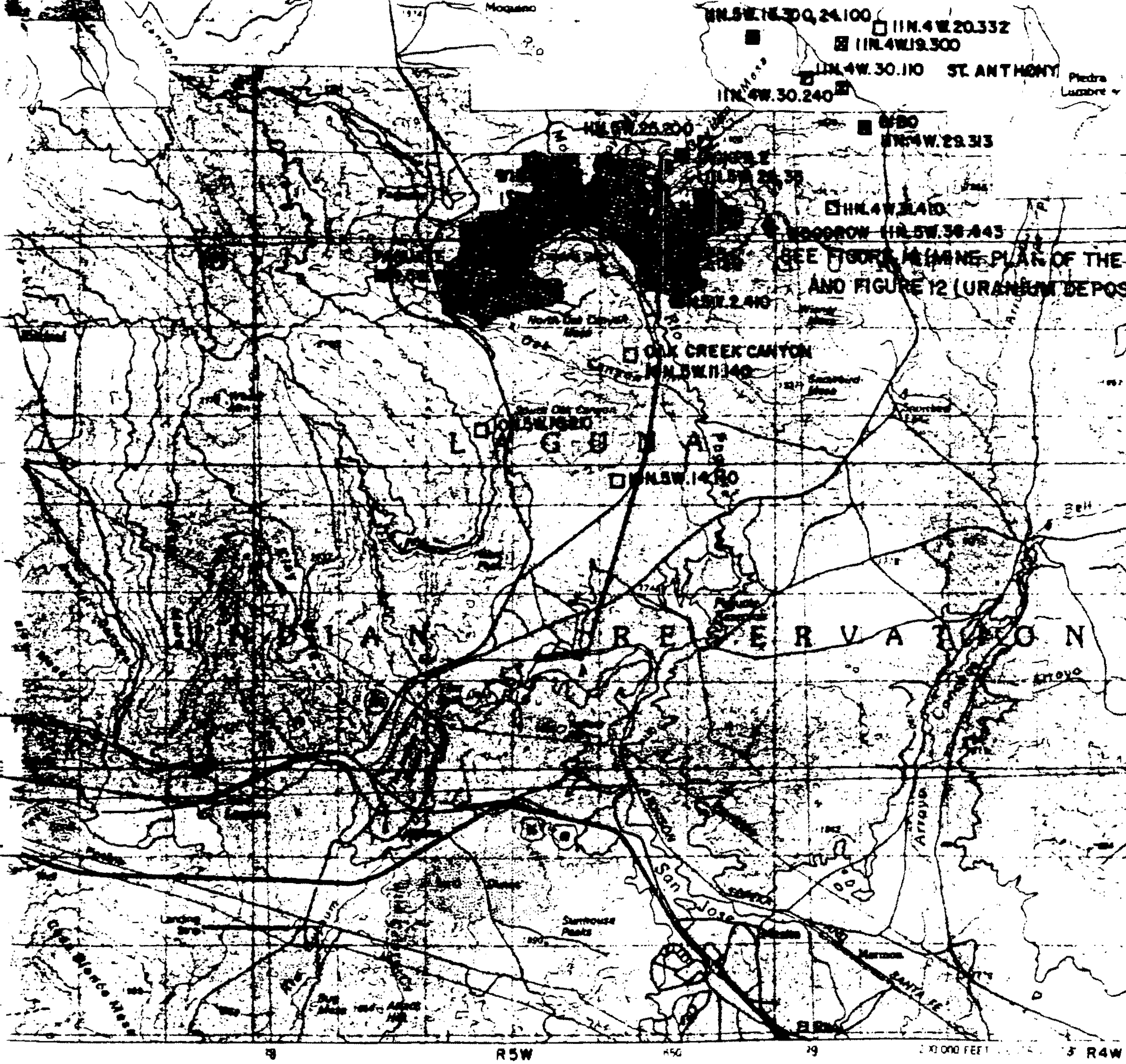


9 Casa Salazar–1961
Bluewater–1957
(Photorevised 1971)
10 Dos Lomas–1957
11 San Mateo–1963
12 Cerro Pelon–1963
13 Laguna Cortaderos–1961
14 Marquez–1961
15 La Gotera–1961
16 Puerco Dam–1961
17 Milan–1957
(Photorevised 1971)
18 Grants–1957
(Photorevised 1971)



... AND OCCURRENCES IN THE GRANTS 30- BY 60-MINUTE ...

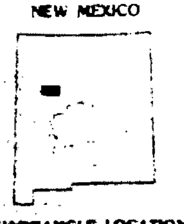
... ICO. EXPLANATION OF SYMBOLS IN TABLE 1-1



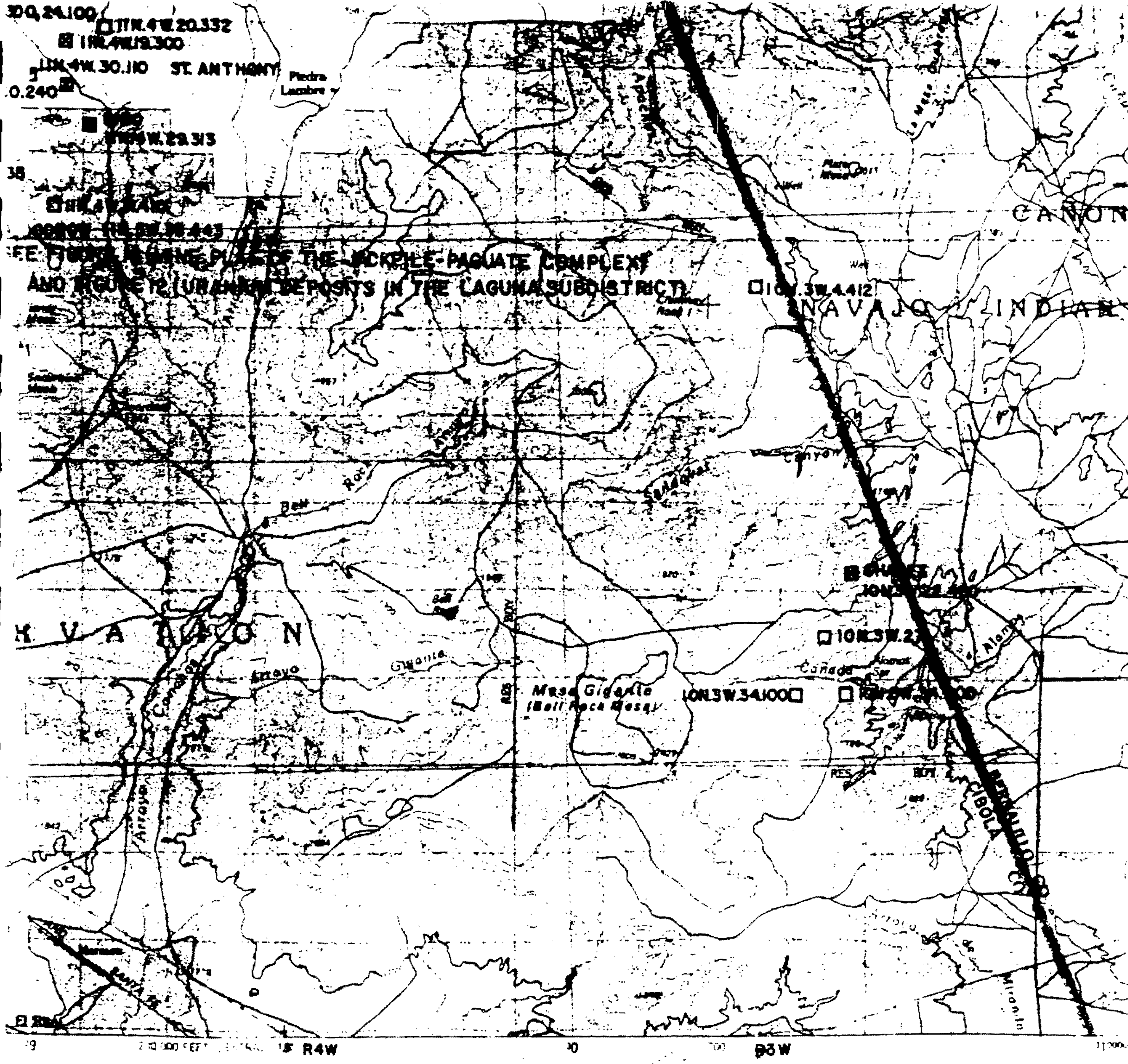
9 10

5

25000



30- BY ... LA SANDOVAL



LEGEND

Perennial stream, lake

Intermittent stream, lake

Village or locality

Landmark structure

Public park or recreation area

Forest or game land area

Other public area or Military or Indian reservation

Primar

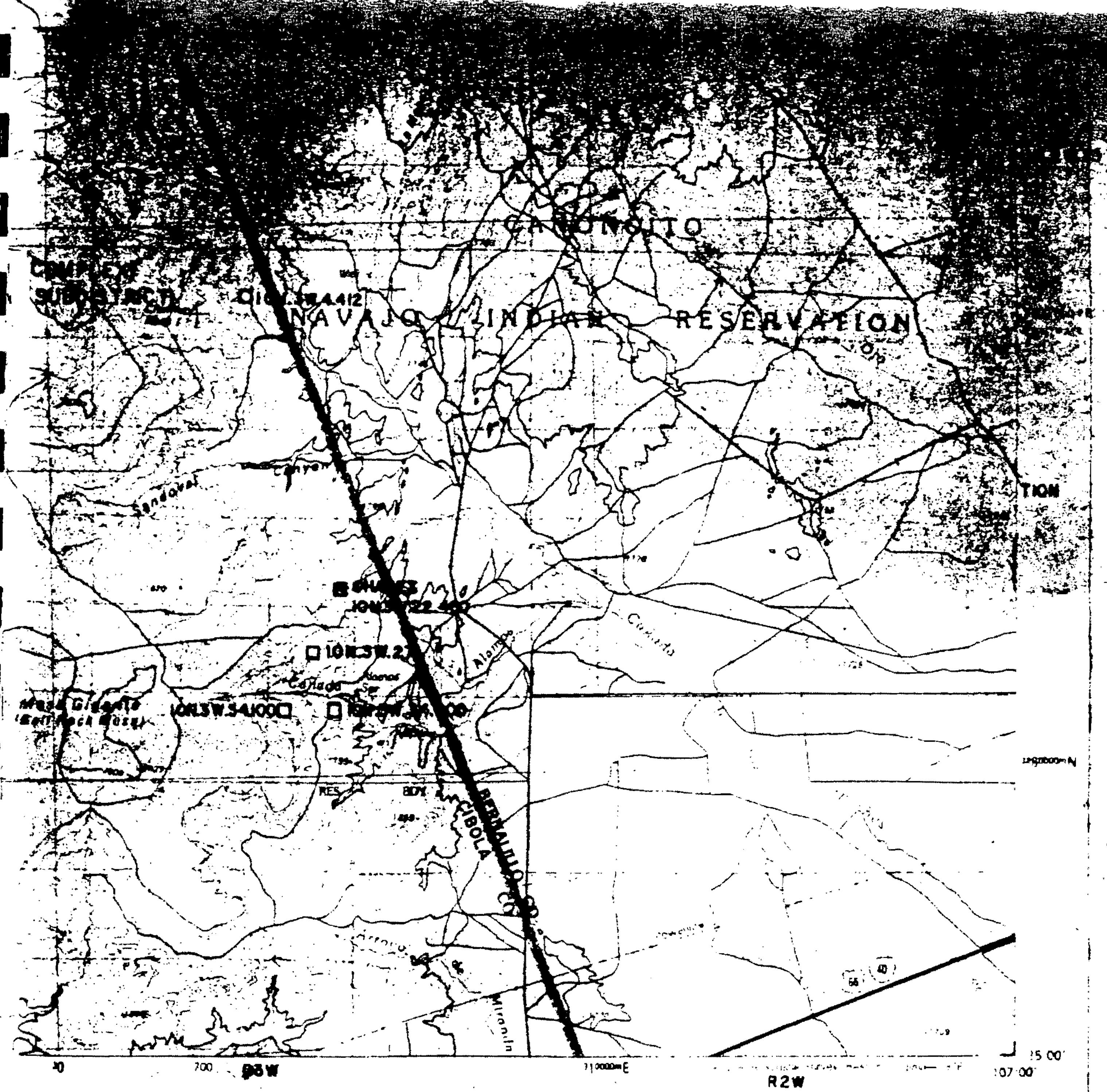
Secon

Light

Street

Trail

CIBOLA, SANDOVAL,



LEGEND

Perennial stream, lake

Intermittent stream, lake

Village or locality

Landmark structure

Public park or recreation area

ROAD CLASSIFICATION

Primary highway, hard surface

Secondary highway, hard surface

Light-duty road, hard or improved surface

Street or unimproved road

Trail

Interstate route U.S. route

GRANTS

REFERENCE # 3

NAVAJO SUPERFUND OFFICE

BROWN VANDEVER URANIUM MINE REFERENCE MATERIAL

MAY, '90 P. MOLLOY

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME PREWITT USEPA SITE NO. NMD980622773

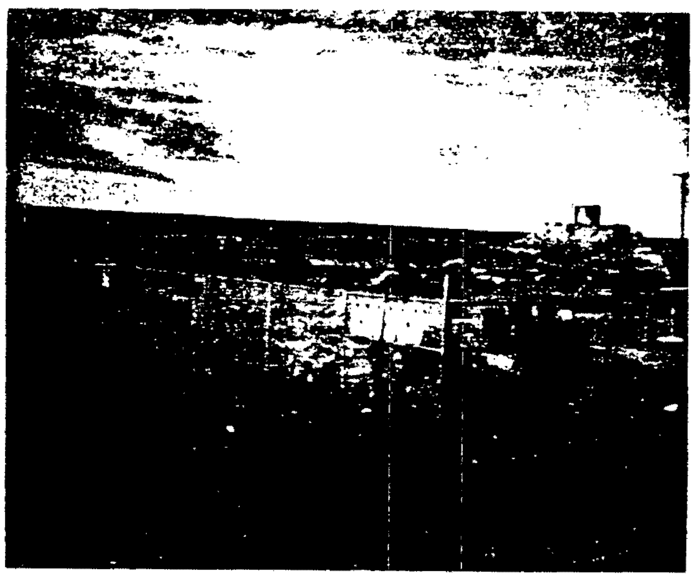
DATE APRIL 11,1990 TIME 10:00 am WEATHER CLEAR

PHOTOGRAPHER P. MOLLOY ANGLE/DIRECTION 235° SW

FILM TYPE POLAROID FRAME NO. 1

DATA TAKEN WITH PHOTOGRAPH: *** NONE ***

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ____________
4. Radiation Survey ( )
   Reading: ____________
5. Deep Well Water Sample ( )
6. Photograph Below: YES



7. DESCRIPTION NW CORNER OF SITE, LOOKING SW: BARRELS AND CATCHMENTS, NO PERSONNEL ON SITE

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME PREWITT USEPA SITE NO. NMD980622773

DATE APRIL 11,1990 TIME 10:00am WEATHER CLEAR

PHOTOGRAPHER P. MOLLOY ANGLE/DIRECTION 225° SW

FILM TYPE POLAROID FRAME NO. 2

DATA TAKEN WITH PHOTOGRAPH: *** NONE ***

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: __________
4. Radiation Survey ( )
   Reading: __________
5. Deep Well Water Sample ( )
6. Photograph Below: YES

3rd Tr.

7. DESCRIPTION NW CORNER OF SITE, LOOKING SW, WINCH, DRILLING RIG AND LAGOONS

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME HAYSTACK BACKGROUND USEPA SITE NO. NONE

DATE APRIL 11,1990 TIME 10:15am WEATHER CLEAR

PHOTOGRAPHER P. MOLLOY ANGLE/DIRECTION 90°/N

FILM TYPE POLAROID FRAME NO. 3

DATA TAKEN WITH PHOTOGRAPH: YES

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ____________
4. Radiation Survey (X)
   Reading: LUDLUM#19-7uR.hr^{-1} :: ESP-II-7(10^3)cpm
5. Deep Well Water Sample ( )
6. Photograph Below: YES

3rd FR.

7. DESCRIPTION HAYSTACK AREA REFERENCE/BACKGROUND CHECK LOCATION, LOOKING N

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE USEPA SITE NO. NOT ASSIGNED

DATE ____________ TIME 10:00am WEATHER CLEAR

PHOTOGRAPHER P. MOLLOY ANGLE/DIRECTION 60°/NNE

FILM TYPE POLAROID FRAME NO. 4

DATA TAKEN WITH PHOTOGRAPH: *** NONE ***

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ____________
4. Radiation Survey ( )
   Reading: ____________
5. Deep Well Water Sample ( )
6. Photograph Below: YES

RES.

7. DESCRIPTION RESIDENCE LOCATIONS W OF HAYSTACK BUTTE, LOOKING NNW

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE USEPA SITE NO. NOT ASSIGNED

DATE APRIL 11,1990 TIME 10:20am WEATHER CLEAR

PHOTOGRAPHER P. MOLLOY ANGLE/DIRECTION 20° ENE

FILM TYPE POLAROID FRAME NO. 5

DATA TAKEN WITH PHOTOGRAPH: NONE

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ______
4. Radiation Survey ( )
   Reading: ______
5. Deep Well Water Sample ( )
6. Photograph Below: YES

5TH FL

7. DESCRIPTION HAYSTACK BUTTE, REFERENT, LOOKING E OF ENE

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

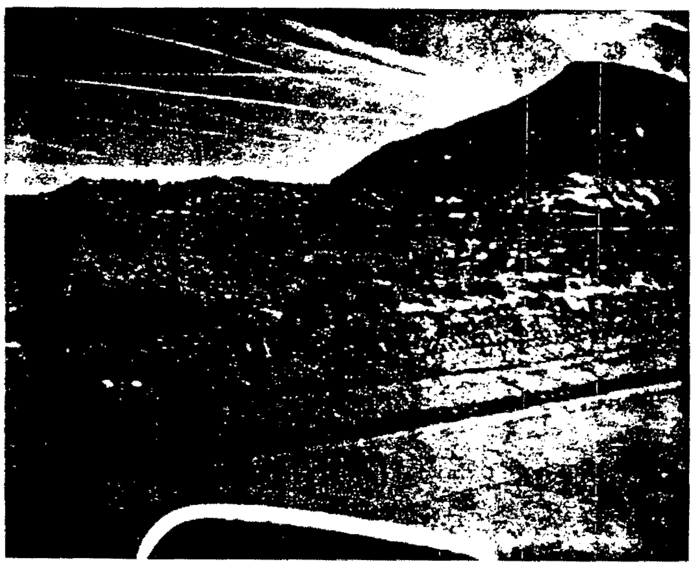
DATE APRIL 11,1990 **TIME** 10:25am **WEATHER** CLEAR

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** ______

FILM TYPE POLAROID **FRAME NO.** 6

DATA TAKEN WITH PHOTOGRAPH: *** NONE ***

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ______
4. Radiation Survey ( )
   Reading: ______
5. Deep Well Water Sample ( )
6. Photograph Below: YES



2 REC.

6TH FR.

7. **DESCRIPTION** RESIDENCES W OF HAYSTACK BUTTE, LOOKING NE

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

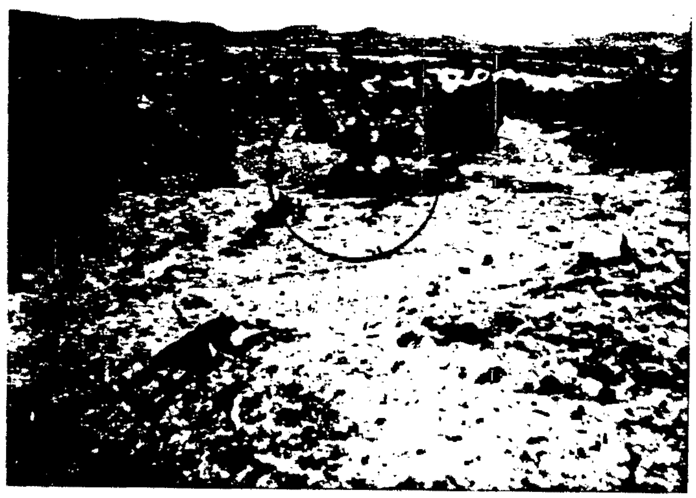
DATE APRIL 11,1990 **TIME** 10:25am **WEATHER** CLEAR

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 20°/ENE

FILM TYPE POLAROID **FRAME NO.** 7

DATA TAKEN WITH PHOTOGRAPH: YES

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ________________
4. Radiation Survey (x)
   Reading: LUDLUM#19-24uR.hr^{-1} :: ESP-II - 2.2(10^4) BACKGROUND @ B VANDEVER
5. Deep Well Water Sample ( )
6. Photograph Below: YES



7th FIR.

7. **DESCRIPTION** TRENCH CUT NNE OF B. VANDEVER RESIDENCE LOOKING NE. NOTE FRAMES 8, 9, 10 TAKEN AT SAME LOCATION

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

DATE APRIL 11,1990 **TIME** 10:25am **WEATHER** CLEAR

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 70°/NNE

FILM TYPE POLAROID **FRAME NO.** 8

DATA TAKEN WITH PHOTOGRAPH: YES, SEE FRAME 7

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ______
4. Radiation Survey (X)
   Reading: ______
5. Deep Well Water Sample ( )
6. Photograph Below: YES

5TH FR.

7. **DESCRIPTION** TAILINGS FROM INCLINED ADIT IN FRAME 12, LOOKING NNE

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

DATE APRIL 11, 1990 **TIME** 10:25am **WEATHER** CLEAR

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 0°/E

FILM TYPE POLAROID **FRAME NO.** 9

DATA TAKEN WITH PHOTOGRAPH: YES, SEE FRAME 7

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ______
4. Radiation Survey (X)
   Reading: ______
5. Deep Well Water Sample ( )
6. Photograph Below: YES

9th FR,

7. DESCRIPTION MT. TAYLOR AS REFERENT IN FAR RIGHT CENTER BACKGROUND, LOOKING E

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE USEPA SITE NO. NOT ASSIGNED

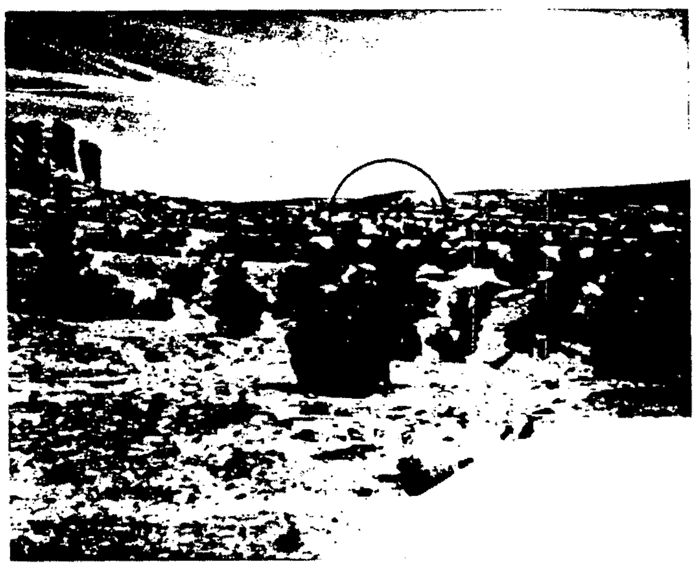
DATE APRIL 11,1990 TIME 10:25am WEATHER CLEAR

PHOTOGRAPHER P. MOLLOY ANGLE/DIRECTION 70° NNE

FILM TYPE POLAROID FRAME NO. 10

DATA TAKEN WITH PHOTOGRAPH: YES, SEE FRAME 7

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ____________
4. Radiation Survey (X)
   Reading: ____________
5. Deep Well Water Sample ( )
6. Photograph Below: YES



2 RES.

10th FR
(MARTINEZ RES.)

7. DESCRIPTION MARTINEZ RESIDENCES AT CENTER MIDDLE-GROUND, LOOKING NNE

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

DATE APRIL 11,1990 **TIME** 10:25am **WEATHER** CLEAR

PHOTOGRAPHER P. MOLLOY ANGLE/DIRECTION -

FILM TYPE POLAROID FRAME NO. 11

DATA TAKEN WITH PHOTOGRAPH: *** NONE ***

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: __________
4. Radiation Survey ( )
   Reading: __________
5. Deep Well Water Sample ( )
6. Photograph Below: NO

7. DESCRIPTION ~~FRAME LOST~~

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE USEPA SITE NO. NOT ASSIGNED

DATE APRIL 11,1990 TIME 10:25am WEATHER CLEAR

PHOTOGRAPHER P. MOLLOY ANGLE/DIRECTION [illegible]

FILM TYPE POLAROID FRAME NO. 12

DATA TAKEN WITH PHOTOGRAPH: YES

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ______
4. Radiation Survey (X)
   Reading: LUDLUM#19 - 21uR.hr^{-1} : @ FACE OF ADIT
5. Deep Well Water Sample ( )
6. Photograph Below: YES

12th FR.

7. DESCRIPTION INCLINED ADIT N OF B. VANDEVER RESIDENCE, LOOKING NNW

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

DATE APRIL 11,1990 **TIME** 10:25am **WEATHER** CLEAR

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 45° NE

FILM TYPE POLAROID **FRAME NO.** 13

DATA TAKEN WITH PHOTOGRAPH: *** NONE ***

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ______
4. Radiation Survey ( )
   Reading: ______
5. Deep Well Water Sample ( )
6. Photograph Below: YES

13TH FR.
(TRENCH & T.P.)

7. **DESCRIPTION** RxR TRENCH AND TAILINGS PILE SSE OF IN-
   CLINED ADIT, LOOKING NE

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

DATE APRIL 11, 1990 **TIME** 10:25am **WEATHER** CLEAR

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** -

FILM TYPE POLAROID **FRAME NO.** 14

DATA TAKEN WITH PHOTOGRAPH: YES

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ______
4. Radiation Survey (X)
   Reading: .1mR.hr^{-1}(LUDLUM#19) @ FACE OF MATERIAL
5. Deep Well Water Sample ( )
6. Photograph Below: YES

1st FR.
("HOT ROCK")

7. DESCRIPTION ORE SAMPLE "HOT ROCK"

FILM TYPE [illegible] FRAME NO. [illegible]

DATA TAKEN WITH PHOTOGRAPH: YES

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ____________
4. Radiation Survey (X)
   Reading: 350uR.hr^{-1}(LUDLUM#19) : @ EDGE OF "
5. Deep Well Water Sample ( )
6. Photograph Below: YES

15TH FR.

[illegible]

J.C.M

7. DESCRIPTION TRENCH AT CENTER MIDDLEGROUND
"LOADING BAY", LOOKING N OF NNE

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

DATE APRIL 11,1990 **TIME** 10:25am **WEATHER** CLEAR

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 10°/N OF NNE

FILM TYPE POLAROID **FRAME NO.** 15

DATA TAKEN WITH PHOTOGRAPH: YES

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ________
4. Radiation Survey (X)
   Reading: 350uR.hr^{-1}(LUDLUM#19) : @ EDGE OF "LOADING BAY"
5. Deep Well Water Sample ( )
6. Photograph Below: YES

15TH FR.

7. DESCRIPTION TRENCH AT CENTER MIDDLEGROUND IS ORE "LOADING BAY", LOOKING N OF NNE

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

DATE APRIL 11,1990 **TIME** 11:15am **WEATHER** CLEAR TO SLIGHTLY OVERCAST

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 45°/NE

FILM TYPE POLAROID **FRAME NO.** 16

DATA TAKEN WITH PHOTOGRAPH: *** NONE ***

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ______________
4. Radiation Survey ( )
   Reading: ______________
5. Deep Well Water Sample ( )
6. Photograph Below: YES

16TH FR - DRAINAGE

7. DESCRIPTION DRAINAGE E OF TAILINGS PILES, LOOKING ENE

NAVAJO SUPERFUND DEPARTMENT

PIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** ~~NOT ASSIGNED~~

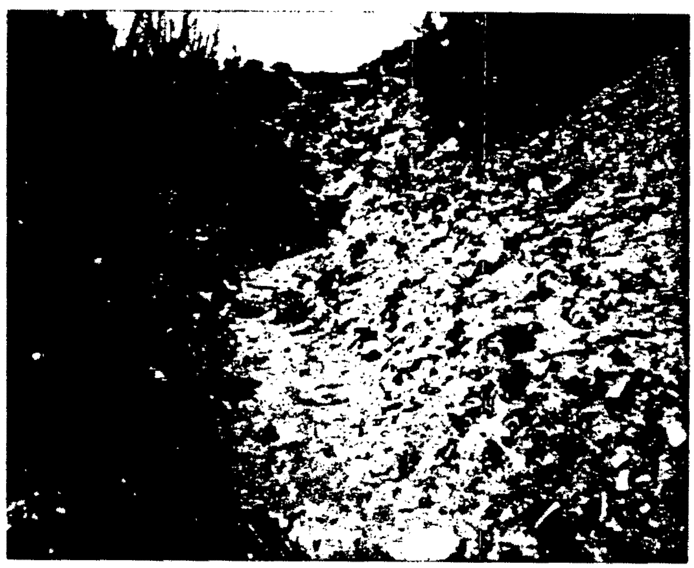
DATE APRIL 11,1990 **TIME** 11:15am **WEATHER** CLEAR TO SLIGHTLY OVERCAST

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 180°/W

FILM TYPE POLAROID **FRAME NO.** 16'

DATA TAKEN WITH PHOTOGRAPH: YES

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ____________
4. Radiation Survey (X)
   Reading: SEE BELOW IN DESCRIPTION
5. Deep Well Water Sample ( )
6. Photograph Below: YES , EXTRA FRAME



16TH FR.
MOUTH OF DRAINAGE

7. **DESCRIPTION** MOUTH OF DRAINAGE, TAILINGS PILE ON RIGHT, ESP-II READINGS: @MOUTH - 5(10^4); @MIDWAY PAST TAILINGS - 6.5(10^4); @END OF TAILINGS - 3.25(10^4); ALL READINGS IN cpm., LOOKING W

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE USEPA SITE NO. ~~NOT ASSIGNED~~

DATE APRIL 11,1990 TIME 11:15am WEATHER CLEAR TO SLIGHTLY OVERCAST

PHOTOGRAPHER P. MOLLOY ANGLE/DIRECTION 90° N

FILM TYPE POLAROID FRAME NO. 17

DATA TAKEN WITH PHOTOGRAPH: YES

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading:
4. Radiation Survey (X)
   Reading: 6.5(10^4)cpm(ESP- II) IN DRAINAGE BELOW CEDAR TREE
5. Deep Well Water Sample ( )
6. Photograph Below: YES

17TE FR

7. DESCRIPTION GAMMA RATEMETER READING IN DRAINAGE E OF TAILINGS PILES(SEE DIAGRAM ON FOLLOWING PAGE), LOOKING N

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE USEPA SITE NO. NOT ASSIGNED

DATE APRIL 11, 1990 TIME 11:15am WEATHER CLEAR TO SLIGHTLY OVERCAST

PHOTOGRAPHER P. MOLLOY ANGLE/DIRECTION 20°/ENE

FILM TYPE POLAROID FRAME NO. 18

DATA TAKEN WITH PHOTOGRAPH: YES

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ________________
4. Radiation Survey (X)
   Reading: $3.5(10^4)$ cpm(ESP-II) : @ BEND IN WASH
5. Deep Well Water Sample ( )
6. Photograph Below: YES

18th FR.

7. DESCRIPTION GAMMA RATEMETER READING DOWN DRAINAGE (E) IN WASH E OF TAILINGS, LOOKING SSE

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

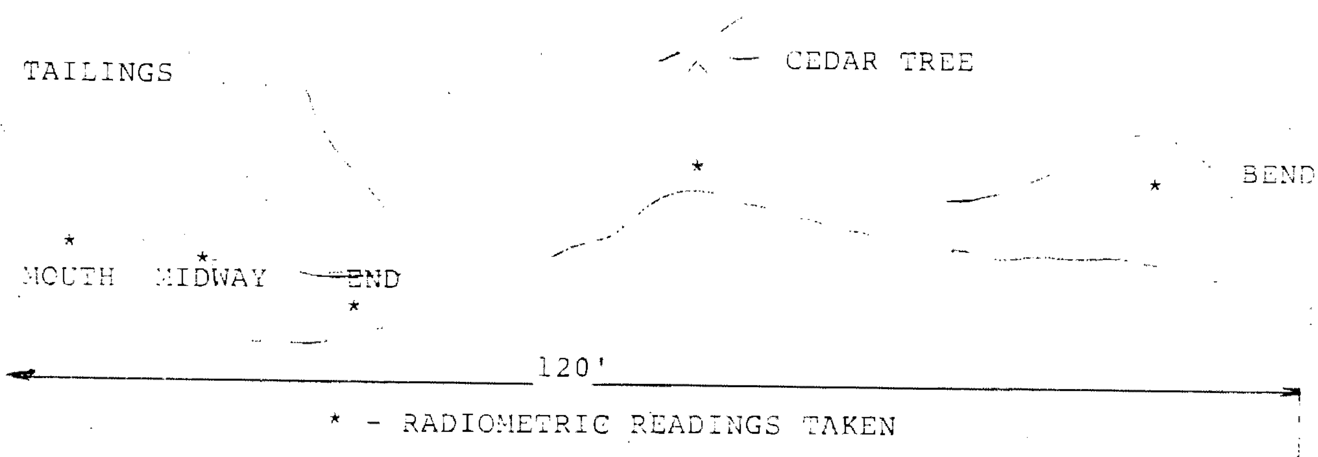
DATE APRIL 11,1990 **TIME** 11:15am **WEATHER** CLEAR TO SLIGHTLY OVERCAST

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** ____

FILM TYPE POLAROID **FRAME NO.** NO FRAME

DATA TAKEN WITH PHOTOGRAPH: SKETCH, OF E FLOWING DRAINAGE

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ____
4. Radiation Survey ( )
   Reading: ____
5. Deep Well Water Sample ( )
6. Photograph Below: *** NONE ***



7. **DESCRIPTION** SKETCH OF DRAINAGE

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE USEPA SITE NO. NOT ASSIGNED

DATE APRIL 11, 1990 TIME 11:15am WEATHER CLEAR TO SLIGHTLY OVERCAST

PHOTOGRAPHER P. MOLLOY ANGLE/DIRECTION 180°/W

FILM TYPE POLAROID FRAME NO. 19

DATA TAKEN WITH PHOTOGRAPH: YES

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ______
4. Radiation Survey (X)
   Reading: 2.5(10^4)cpm(ESP-II) @ENTRANCE TO TRENCH
5. Deep Well Water Sample ( )
6. Photograph Below: YES

1974 ER
(TRENCH & "SPOT")

7. DESCRIPTION TRENCH CUT NE OF B. VANDEVER RES., SEE ACCOMPANYING SKETCH ON FOLLOWING PAGE, LOOKING W.

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

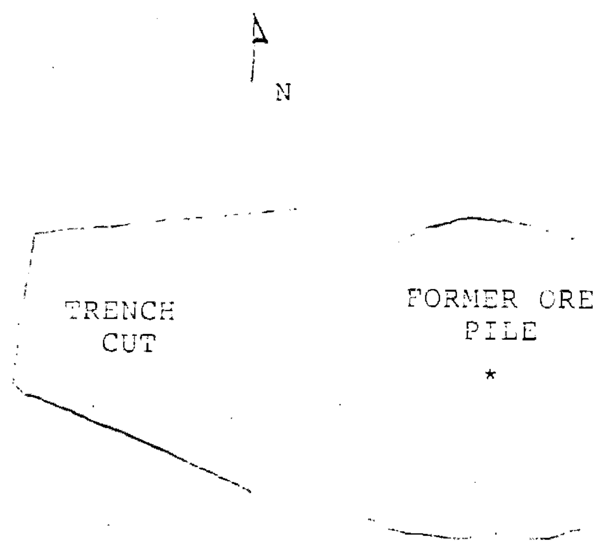
DATE APRIL 11,1990 **TIME** 10:25am **WEATHER** CLEAR

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** -

FILM TYPE POLAROID **FRAME NO.** NO FRAME

DATA TAKEN WITH PHOTOGRAPH: SEE PREVIOUS FRAME

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ______
4. Radiation Survey (X)
   Reading: ______
5. Deep Well Water Sample ( )
6. Photograph Below: *** SKETCH ***



* - 2.5(104)cpm

7. **DESCRIPTION** SKETCH OF TRENCH CUT NE OF B.V. RESIDENCE

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

DATE APRIL 11,1990 **TIME** AFTERNOON **WEATHER** CLEAR

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 90° N

FILM TYPE POLAROID **FRAME NO.** 20

DATA TAKEN WITH PHOTOGRAPH: *** NONE ***

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ____________
4. Radiation Survey ( )
   Reading: ____________
5. Deep Well Water Sample ( )
6. Photograph Below: YES

20TH FR.
(GEOL.?)

7. **DESCRIPTION** REFERENCE FRAME - GEOLOGY/FORMATIONS PRESENT @ HAYSTACK BUTTE, LOOKING N., SEE FOLLOWING ANNOTATED PHOTO FACSIMILE

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

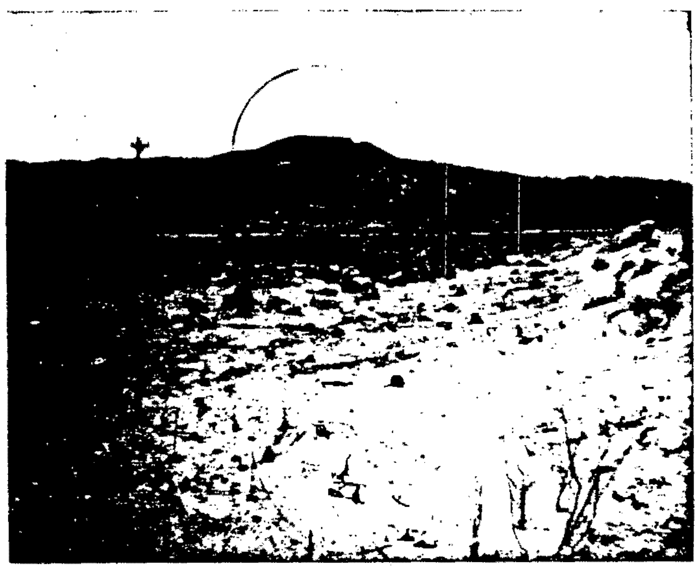
DATE APRIL 11,1990 **TIME** AFTERNOON **WEATHER** CLEAR

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 270 / S

FILM TYPE POLAROID **FRAME NO.** 20'

DATA TAKEN WITH PHOTOGRAPH: *** NONE ***

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ________
4. Radiation Survey ( )
   Reading: ________
5. Deep Well Water Sample ( )
6. Photograph Below: YES



20TH FR. (EL TINTERO CINDER CONE, REF.)

7. **DESCRIPTION** EL TINTERO CINDER CONE REFERENT, LOOKING S

DAKOTA Kd

MORRISON
FORMATION
Jm

COW SPRINGS
SS
Jcs

SUMMERVILLE Js

TODILTO
Jt

20TH FR.
(GEOL.)

NAVAJO SUPERFUND OFFICE

BROWN VANDEVER URANIUM MINE
LOCAL GEOLOGY: PATRICK
ANTONIO, NSO STAFF HYDROLO-
GIST TO P. MOLLOY JCM

APRIL, '90 P. MOLLOY

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED
DATE APRIL 11,1990 **TIME** AFTERNOON **WEATHER** CLEAR
PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 200°/WSW
FILM TYPE POLAROID **FRAME NO.** 21

DATA TAKEN WITH PHOTOGRAPH: *** NONE ***

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ______________
4. Radiation Survey ( )
   Reading: ______________
5. Deep Well Water Sample ( )
6. Photograph Below: YES

2 RES.

21ST FR.

7. **DESCRIPTION** B. VANDEVER OUTFIT RESIDENCES, LOOKING WSW

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

DATE APRIL 11,1990 **TIME** AFTERNOON **WEATHER** CLEAR

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 0°/E

FILM TYPE POLAROID **FRAME NO.** 22

DATA TAKEN WITH PHOTOGRAPH: YES

1. **Soil Sample** ( )
2. **Surface Water Sample** ( )
3. **Air Monitoring Device** ( )
   Reading: __________
4. **Radiation Survey** (x)
   Reading: 10^5 cpm(ESP-II) @ EDGE OF ROAD
5. **Deep Well Water Sample** ( )
6. **Photograph Below:** YES

22nd

7. **DESCRIPTION** "HOT ROAD" WEST OF B. V. RESIDENCES, SURFACE WORKS WASTE PILES @ RIGHT MIDDLEGROUND, MT. TAYLOR @ UPPER LEFT BACKGROUND AS REFERENT

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

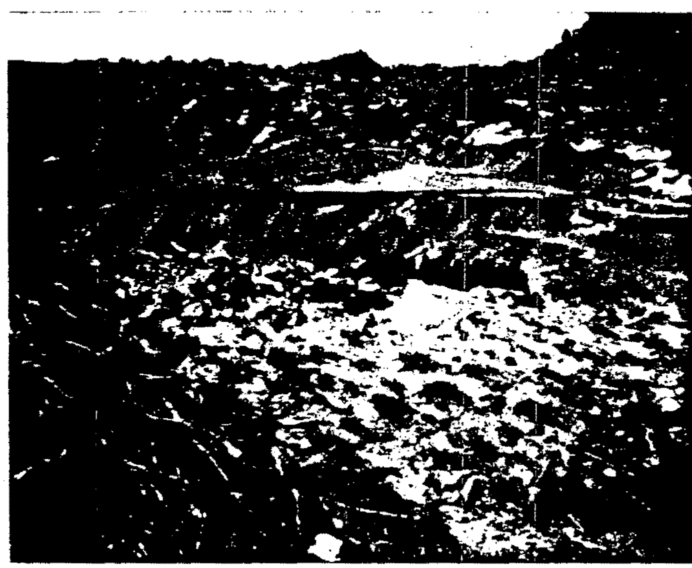
DATE APRIL 11,1990 **TIME** ________ **WEATHER** CLEAR

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 270° /W

FILM TYPE POLAROID **FRAME NO.** 23

DATA TAKEN WITH PHOTOGRAPH: *** NONE ***

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ____________
4. Radiation Survey (X)
   Reading: ____________
5. Deep Well Water Sample ( )
6. Photograph Below: YES



23nd FR - T.P.
(N. VANDEVER?)

DRAIN

7. **DESCRIPTION** NANA - A - BAH VANDEVER MINE ? WESTERN EXTENT OF B. VANDEVER WORKS, NOTE DRAINAGE, LOOK-ING W

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

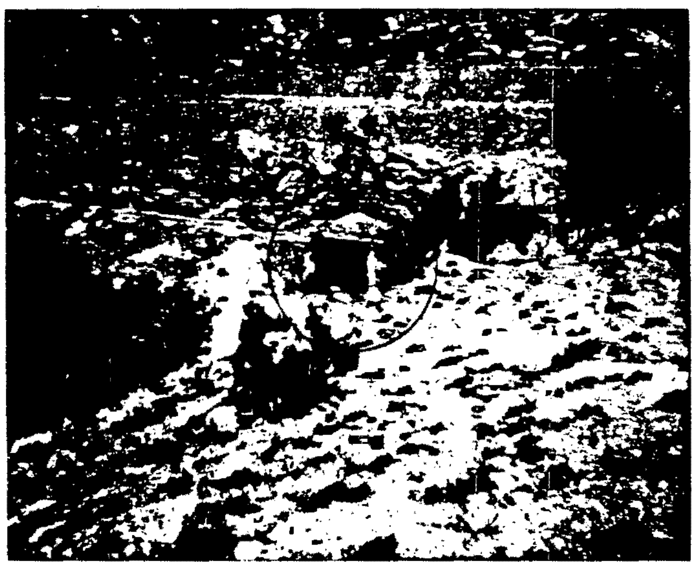
DATE APRIL 11,1990 **TIME** AFTERNOON **WEATHER** CLEAR

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 135°/NW

FILM TYPE POLAROID **FRAME NO.** 24

DATA TAKEN WITH PHOTOGRAPH: *** NONE ***

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ________
4. Radiation Survey (X)
   Reading: ________
5. Deep Well Water Sample ( )
6. Photograph Below: YES



24TH FR. - ADIT
(N. VANEVER ?)

7. **DESCRIPTION** NANA - A - BAH VANDEVER MINE ADIT TRENDING N, ADIT IS BARRED

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

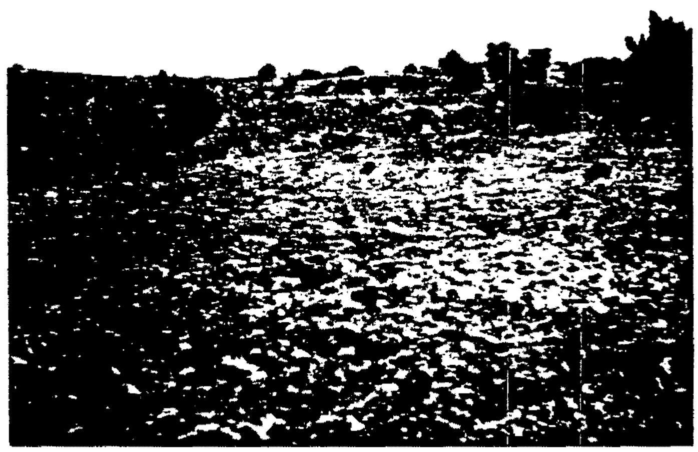
DATE APRIL 11,1990 **TIME** AFTERNOON **WEATHER** CLEAR

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 315°/ESE

FILM TYPE POLAROID **FRAME NO.** 25

DATA TAKEN WITH PHOTOGRAPH: *** NONE ***

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ______________
4. Radiation Survey (X)
   Reading: ______________
5. Deep Well Water Sample ( )
6. Photograph Below: YES



25TH Fr

7. **DESCRIPTION** WESTERN EXTENT OF SURFACE WORKS NSW OF B. V. RESIDENCE, LOOKING ESE

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

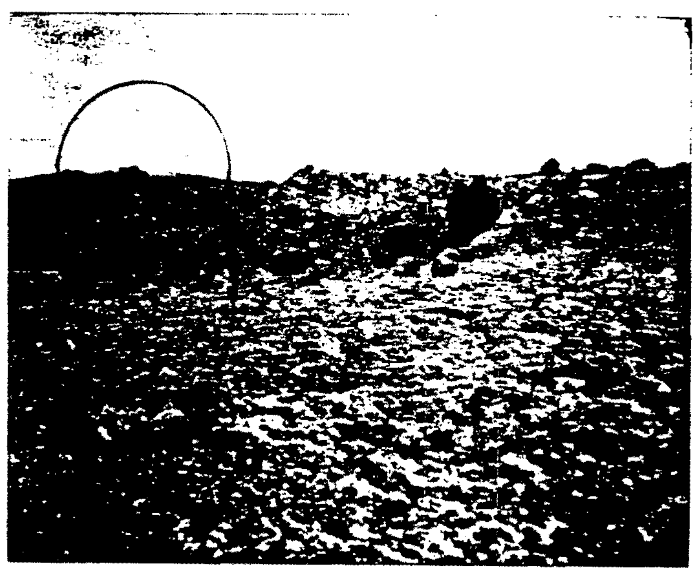
DATE APRIL 11,1990 **TIME** AFTERNOON **WEATHER** CLEAR

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 350°/E OF ESE

FILM TYPE POLAROID **FRAME NO.** 26

DATA TAKEN WITH PHOTOGRAPH: *** NONE ***

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ____________
4. Radiation Survey (X)
   Reading: ____________
5. Deep Well Water Sample ( )
6. Photograph Below: YES



26TH Fr

7. **DESCRIPTION** SURFACE WORKS WSW OF B. V. RES., LOOKING E OF ESE; NOTE MT. TAYLOR IN FAR LEFT BACKGROUND AS REFERENT

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

DATE APRIL 11,1990 **TIME** AFTERNOON **WEATHER** CLEAR - HIGH HAZY CLOUDS

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 20°/E OF ENE

FILM TYPE POLAROID **FRAME NO.** 27

DATA TAKEN WITH PHOTOGRAPH: YES, NOT WRITTEN DOWN

1. **Soil Sample** ( )
2. **Surface Water Sample** ( )
3. **Air Monitoring Device** ( )
   Reading: ______
4. **Radiation Survey** (X)
   Reading: ~~150uR.hr-1~~(LUDLUM#19), 10^4cpm(ESP-II)
5. **Deep Well Water Sample** ( ) *** APPROXIMATE ***
6. **Photograph Below:** YES

27 ~~34~~ FR

7. **DESCRIPTION** SURFACE WORKS WSW OF B. V. RES., SEE FOLLOWING SKETCH, LOOKING E OF ENE

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

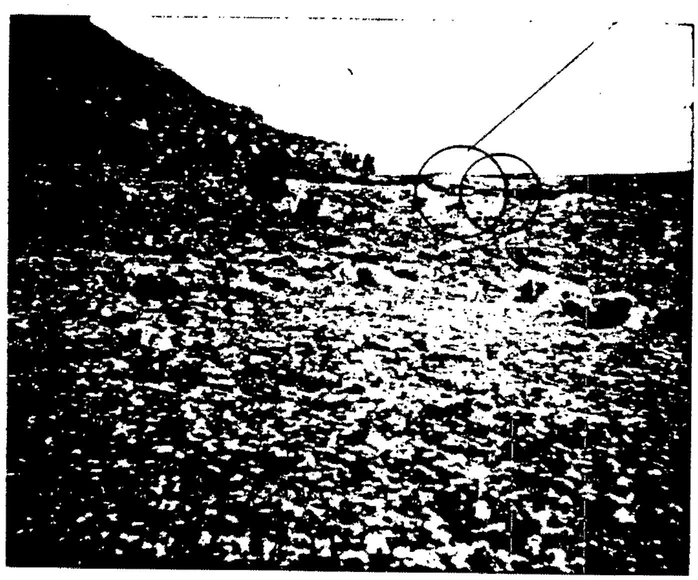
DATE APRIL 11,1990 **TIME** ________ **WEATHER** CLEAR

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** ________

FILM TYPE POLAROID **FRAME NO.** 28

DATA TAKEN WITH PHOTOGRAPH: *** NONE ***

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ________
4. Radiation Survey (X)
   Reading: ________
5. Deep Well Water Sample ( )
6. Photograph Below: YES, SEE SKETCH



28 = Fr.

7. DESCRIPTION SEE SKETCH

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE USEPA SITE NO. NOT ASSIGNED
DATE APRIL 11,1990 TIME 11:15am WEATHER CLEAR TO SLIGHTLY OVERCAST
PHOTOGRAPHER P. MOLLOY ANGLE/DIRECTION SEE SKETCH
FILM TYPE POLAROID FRAME NO. 29

DATA TAKEN WITH PHOTOGRAPH: *** NONE ***

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ________________
4. Radiation Survey ( )
   Reading: ________________
5. Deep Well Water Sample ( )
6. Photograph Below: YES

29TH FR.

7. DESCRIPTION ____

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

DATE APRIL 11,1990 **TIME** 11:15am **WEATHER** CLEAR TO SLIGHTLY OVERCAST

PHOTOGRAPHER P. MOLLOY ANGLE/DIRECTION SEE SKETCH

FILM TYPE POLAROID FRAME NO. 30

DATA TAKEN WITH PHOTOGRAPH: *** NONE ***

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ________________
4. Radiation Survey (X)
   Reading: ________________
5. Deep Well Water Sample ( )
6. Photograph Below: YES

30TH Fk.

7. DESCRIPTION ____

____

____

____

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

DATE APRIL 11,1990 **TIME** 11:15am **WEATHER** CLEAR TO SLIGHTLY OVERCAST

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** SEE SKETCH

FILM TYPE POLAROID **FRAME NO.** 31

DATA TAKEN WITH PHOTOGRAPH:

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: __________
4. Radiation Survey (x)
   Reading: __________
5. Deep Well Water Sample ( )
6. Photograph Below: YES

31ST FR.

7. DESCRIPTION ____________________

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

DATE APRIL 11,1990 **TIME** 2:30pm **WEATHER** CLEAR TO SLIGHTLY OVERCAST

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** SEE SKETCH

FILM TYPE POLAROID **FRAME NO.** 32

DATA TAKEN WITH PHOTOGRAPH: *** NONE ***

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: __________
4. Radiation Survey (X)
   Reading: __________
5. Deep Well Water Sample ( )
6. Photograph Below: YES

32 @ FR. LKG S

7. DESCRIPTION __________

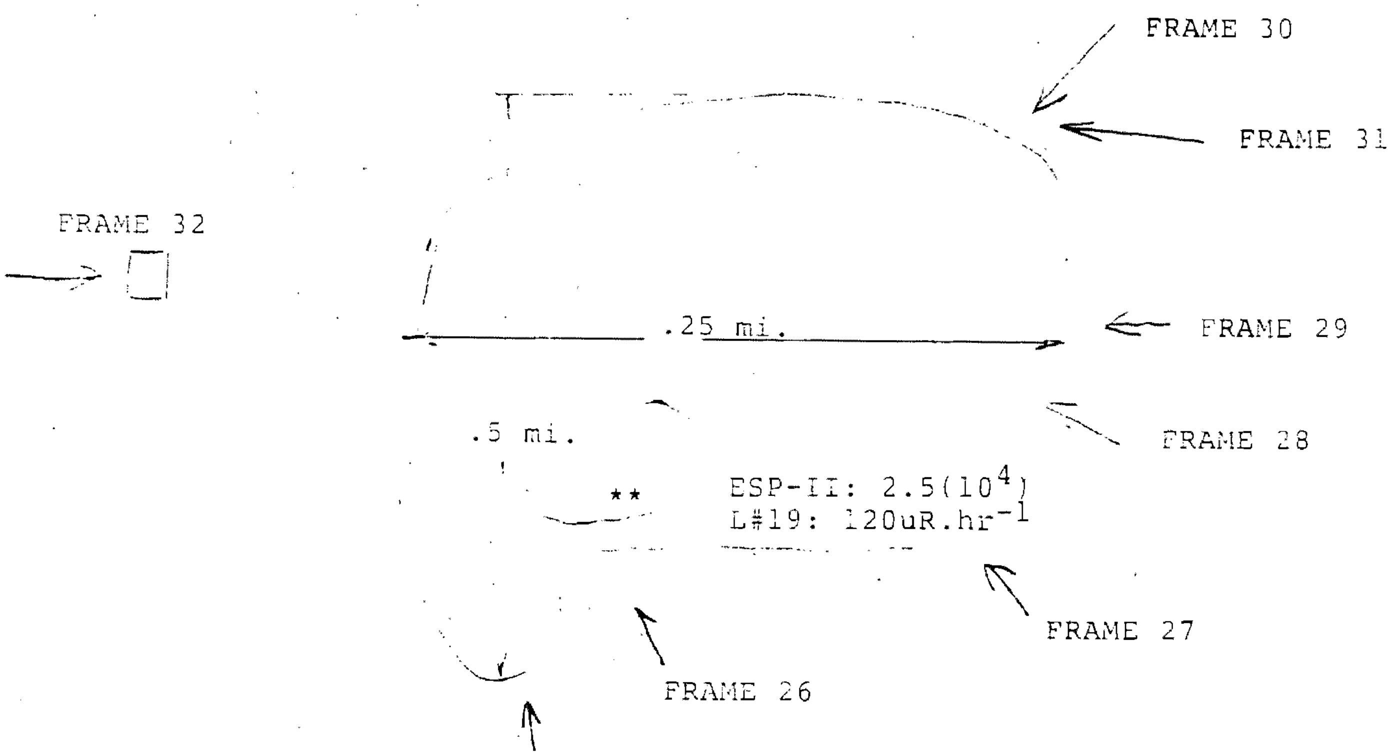
NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE USEPA SITE NO. NOT ASSIGNED
DATE APRIL 11,1990 TIME 11:15am WEATHER CLEAR TO SLIGHTLY OVERCAST
PHOTOGRAPHER P. MOLLOY ANGLE/DIRECTION -
FILM TYPE POLAROID FRAME NO. NO FRAME

DATA TAKEN WITH PHOTOGRAPH: SKETCH

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: __________
4. Radiation Survey (X)
   Reading: SEE BELOW
5. Deep Well Water Sample ( )
6. Photograph Below: *** NONE ***



* RADIOMETRIC READINGS ASSOCIATED WITH FRAME 27

7. DESCRIPTION SKETCH OF AREA WHERE RADIOMETRIC READINGS WERE TAKEN, NO SCALE

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** ~~NOT ASSIGNED~~

DATE APRIL 11,1990 **TIME** AFTERNOON **WEATHER** CLEAR TO SLIGHTLY OVERCAST

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 135°/NW

FILM TYPE POLAROID **FRAME NO.** 33

DATA TAKEN WITH PHOTOGRAPH: YES

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: __________
4. Radiation Survey (X)
   Reading: 10uR.hr^{-1}(LUDLUM#19), 10^{4}cpm(ESP-II) @ WEST FACE OF SHACK
5. Deep Well Water Sample ( )
6. Photograph Below: YES

33@ ER.

7. **DESCRIPTION** B. VANDEVER TIMBERED SHAFT, SHAFT AT AN INCLINATION OF 10° FROM VERTICAL, CIRCULAR APERTURE ON S FACING WALL IS WIRED OVER BUT WIRE IS EASILY REMOVED, SHAFT ASPIRATES, "300 FT. DEEP" B. V. TO P. MOLLOY, APRIL 11,1990

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED
DATE APRIL 11,1990 **TIME** AFTERNOON **WEATHER** CLEAR TO SLIGHTLY OVERCAST
PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 250°/WNW
FILM TYPE POLAROID **FRAME NO.** 33

DATA TAKEN WITH PHOTOGRAPH: *** NONE ***

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ______________
4. Radiation Survey (X)
   Reading: ______________
5. Deep Well Water Sample ( )
6. Photograph Below: YES

33rd FR.
(VENT. SH. VERTICAL!)

7. **DESCRIPTION** VERTICAL VENTILATION SHAFTS(2), HOSTEEN BROWN VANDEVER AT RIGHT MIDDLEGROUND, SHAFTS "300 FT. DEEP" - B. V. TO P. MOLLOY, APRIL 11,1990, LOOK-WNW

PCM

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

DATE APRIL 11,1990 **TIME** AFTERNOON **WEATHER** CLEAR TO SLIGHTLY OVERCAST

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 0° / E

FILM TYPE POLAROID **FRAME NO.** 34

DATA TAKEN WITH PHOTOGRAPH: *** NONE ***

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ________
4. Radiation Survey (X)
   Reading: NONE
5. Deep Well Water Sample ( )
6. Photograph Below: YES

54 I4 FR

7. **DESCRIPTION** DRAINAGE E OF B. VANDEVER RESIDENCE, FLOWS APPROXIMATELY SE. NOTE MT. TAYLOR IN MIDDLE BACKGROUND AS REFERENT.

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

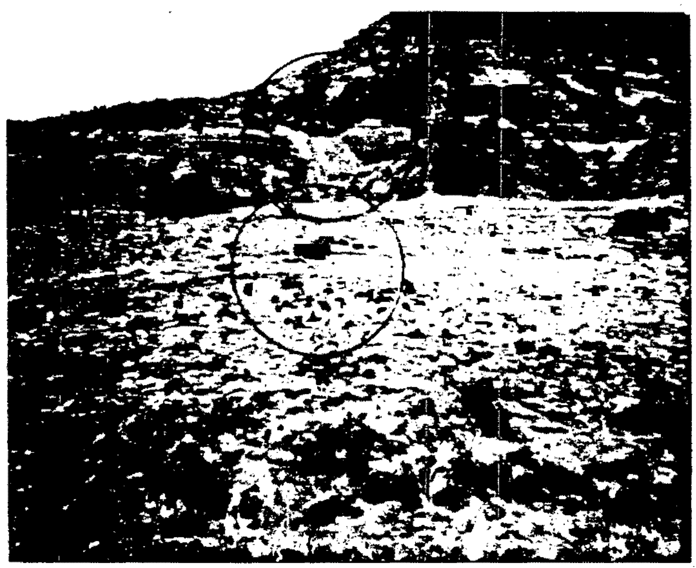
DATE APRIL 11,1990 **TIME** AFTERNOON **WEATHER** CLEAR TO SLIGHTLY OVERCAST

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 75°/NNE

FILM TYPE POLAROID **FRAME NO.** 35

DATA TAKEN WITH PHOTOGRAPH: *** NONE ***

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ____________
4. Radiation Survey (X)
   Reading: NONE
5. Deep Well Water Sample ( )
6. Photograph Below: YES



@ 5TH FL.
NOTE TAILINGS @ FORE CTR MGND

7. **DESCRIPTION** ARTESIAN WELL SSW OF HAYSTACK BUTTE
WELL USED FOR STOCKWATER AND ?. NOTE N. VANDEVER
URANIUM MINE TAILINGS PILE @ CENTER MIDDLEGROUND.

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

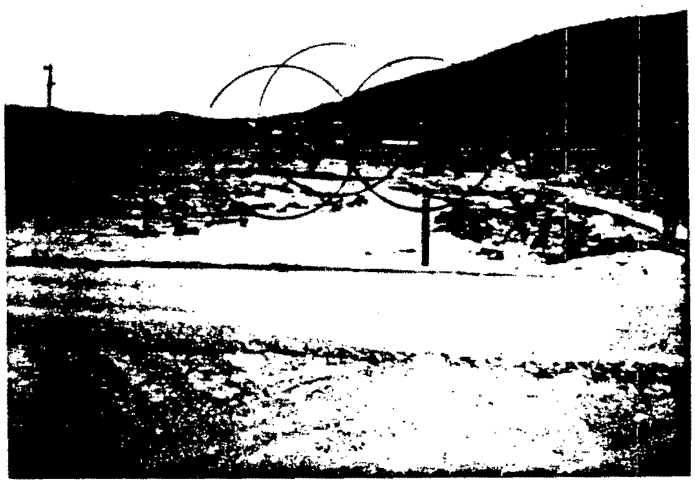
DATE APRIL 11,1990 **TIME** AFTERNOON **WEATHER** CLEAR TO SLIGHTLY OVERCAST

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 30° ENE

FILM TYPE POLAROID **FRAME NO.** 36

DATA TAKEN WITH PHOTOGRAPH: *** NONE ***

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ______________
4. Radiation Survey (X)
   Reading: NONE
5. Deep Well Water Sample ( )
6. Photograph Below: YES



Poor REC.

36TH FR.

7. **DESCRIPTION** HAYSTACK COMMUNITY RESIDENCE SURVEY.WNW OF HAYSTACK BUTTE.

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

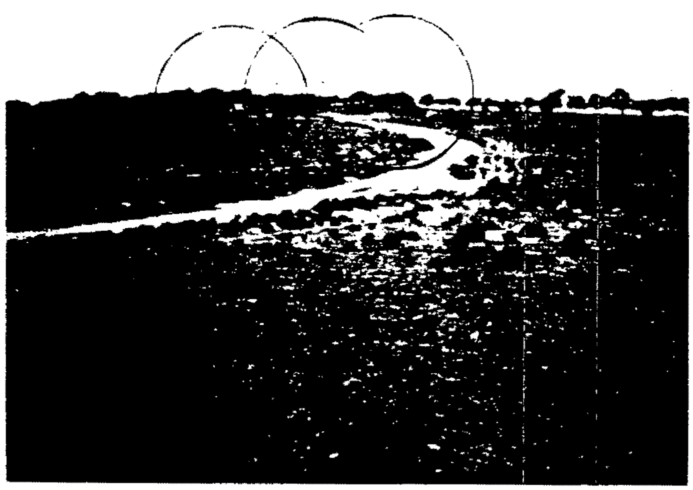
DATE APRIL 11,1990 **TIME** AFTERNOON **WEATHER** CLEAR TO SLIGHTLY OVERCAST

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 30° N

FILM TYPE POLAROID **FRAME NO.** 37

DATA TAKEN WITH PHOTOGRAPH: *** NONE ***

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ______________
4. Radiation Survey (X)
   Reading: NONE
5. Deep Well Water Sample ( )
6. Photograph Below: YES



~ RES.

37TH FR.

7. **DESCRIPTION** HAYSTACK COMMUNITY RESIDENCE SURVEY, WNW OF HAYSTACK BUTTE.

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

DATE APRIL 11,1990 **TIME** AFTERNOON **WEATHER** CLEAR TO SLIGHTLY OVERCAST

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 300° NNW

FILM TYPE POLAROID **FRAME NO.** 38

DATA TAKEN WITH PHOTOGRAPH: *** NONE ***

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ____________
4. Radiation Survey (X)
   Reading: NONE
5. Deep Well Water Sample ( )
6. Photograph Below: YES

1-22,

38th FR.

7. **DESCRIPTION** HAYSTACK COMMUNITY RESIDENCE SURVEY, NW OF HAYSTACK BUTTE.

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

DATE APRIL 11,1990 **TIME** AFTERNOON **WEATHER** CLEAR TO SLIGHTLY OVERCAST

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 35°/NW

FILM TYPE POLAROID **FRAME NO.** 38

DATA TAKEN WITH PHOTOGRAPH: *** NONE ***

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ____________
4. Radiation Survey (X)
   Reading: NONE
5. Deep Well Water Sample ( )
6. Photograph Below: YES

SEE FRAME #

39TH FR.

7. **DESCRIPTION** HAYSTACK COMMUNITY RESIDENCE SURVEY, NW OF HAYSTACK BUTTE.

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

DATE APRIL 11,1990 **TIME** AFTERNOON **WEATHER** CLEAR TO SLIGHTLY OVERCAST

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 340° ESE

FILM TYPE POLAROID **FRAME NO.** 40

DATA TAKEN WITH PHOTOGRAPH: *** NONE ***

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ________
4. Radiation Survey (X)
   Reading: NONE
5. Deep Well Water Sample ( )
6. Photograph Below: YES

3 EES.

40TH FR

7. **DESCRIPTION** HAYSTACK COMMUNITY RESIDENCE SURVEY, NNE OF HAYSTACK BUTTE.

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

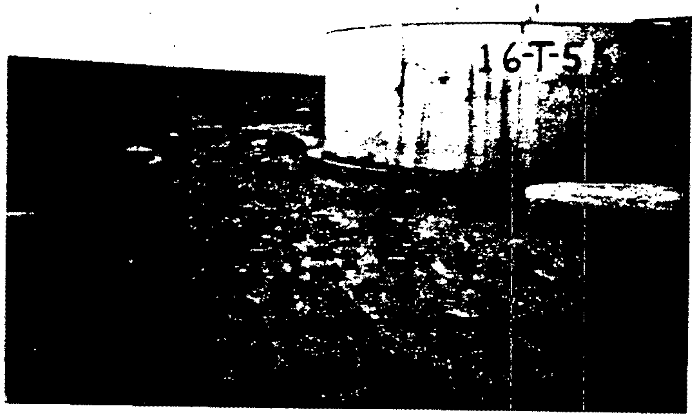
DATE APRIL 11,1990 **TIME** AFTERNOON **WEATHER** CLEAR TO SLIGHTLY OVERCAST

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 200°/WSW

FILM TYPE POLAROID **FRAME NO.** 41

DATA TAKEN WITH PHOTOGRAPH: *** NONE ***

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ____________
4. Radiation Survey (X)
   Reading: NONE
5. Deep Well Water Sample ( )
6. Photograph Below: YES



41st FR.

7. **DESCRIPTION** WELL 16T-552 DUE W OF HAYSTACK BUTTE 1.4 mi.; WELL NOT FUNCTIONAL

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

DATE MAY 11,1990 **TIME** 12:30pm **WEATHER** BROKEN CLOUDS, WINDY

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 180° W

FILM TYPE POLAROID **FRAME NO.** 1

DATA TAKEN WITH PHOTOGRAPH: *** NO ***

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: __________
4. Radiation Survey (x)
   Reading: __________
5. Deep Well Water Sample ( )
6. Photograph Below: ROAD DUE E OF B. VANDEVER OUTFIT

FR. #1, LKG W

7. DESCRIPTION NOTE RESIDENCES ON HORIZON, LOOKING W

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

DATE MAY 11, 1990 **TIME** 1:30pm **WEATHER** BROKEN CLOUDS, WINDY

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 60°/NE

FILM TYPE POLAROID **FRAME NO.** 2

DATA TAKEN WITH PHOTOGRAPH: YES

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: __________
4. Radiation Survey (X)
   Reading: LUDLUM#19 - RANGE: 11 - 22uR.hr^{-1}
   ESP - II-RANGE: 1.1 - 2.5(10^4)cpm
5. Deep Well Water Sample ( )
6. Photograph Below: DRAINAGE SW OF N. VANDEVER URANIUM MINE

FR. #2, LKG NE

7. **DESCRIPTION** MIGRATION OF RADIOACTIVE MATERIAL ACROSS ROAD UNCERTAIN DUE TO RADIOACTIVE MATERIAL DEPOSITED ON ROAD DURING HAULING OPERATIONS. NOTE SHEEP GRAZING IN FIELD, RIGHT CENTER MIDDLEGROUND.

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

DATE MAY 11,1990 **TIME** 2:00pm **WEATHER** BROKEN CLOUDS, WINDY

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 320°/SE

FILM TYPE POLAROID **FRAME NO.** 3

DATA TAKEN WITH PHOTOGRAPH: YES, SEE PREVIOUS FRAME

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ______________
4. Radiation Survey (x)
   Reading: ______________
5. Deep Well Water Sample ( )
6. Photograph Below: CONTINUATION OF DRAINAGE SW OF N. VANDEVER URANIUM MINE

FR. #3; LKG SE

7. DESCRIPTION ROAD IS OLD HAULAGE ROAD

REFERENCE # 4

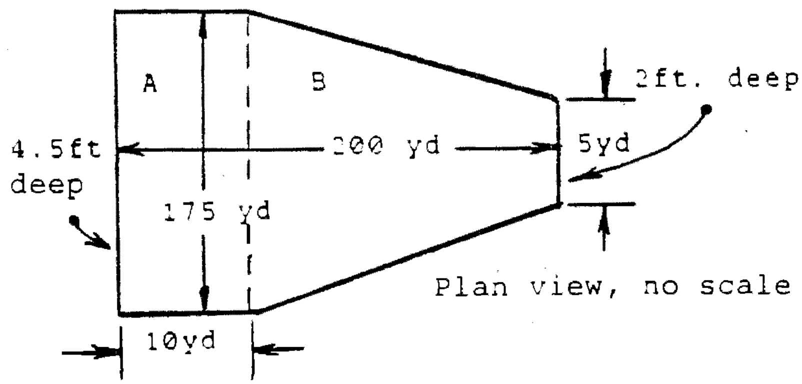
NAVAJO SUPERFUND OFFICE

BROWN VANDEVER URANIUM MINE REFERENCE MATERIAL

MAY, '90 R. MOLLOY

Mine spoils calculations for the Brown Vandever uranium mine

1. From frame #15 of Ref #3 and field notes page #3 (Ref #14) consider that the tailings pile has the geometric shape;



It follows that

$$V_A = (525\text{ft.})(30\text{ft.})(4.5\text{ft.})$$
$$= 7.09(10^4)\text{ft}^3$$

and

$$V_B = (570\text{ft.})\left(\frac{15\text{ft.} + 525\text{ft}}{(2)}\right)\left(\frac{4.5\text{ft.} + 2\text{ft}}{(2)}\right)$$
$$= 5(10^5)\text{ft}^3$$

2. The combined geometric volume is;

$$V_{geo} = 5.7(10^5)\text{ft}^3 \text{ or } V_{geo} = 1.62(10^{10})\text{cm}^3$$

3. Compensate this volume for void volume overestimate to obtain;

$$V_{TP} \simeq (.7)(1.62(10^{10}))\text{cm}^3 = 1.13(10^{10})\text{cm}^3.$$

4. Assume that the percentage of U_3O_8 within this volume is 10^{-2}% whereby;
$$V_{U_3O_8} = 1.13(10^6)\text{cm}^3.$$

5. From general assumptions, the density of U_3O_8 was found to be 23.26 gm. cm^{-3} Applying this quantity to volume of U_3O_8 find
$$M_{U_3O_8} = 2.63(10^4)\text{kg}$$
$$\approx 30 \text{ tons}$$

NAVAJO SUPERFUND OFFICE

BROWN VANDEVER URANIUM MINE

MAY,'90 P. MOLLOY

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME HAYSTACK BACKGROUND **USEPA SITE NO.** NONE

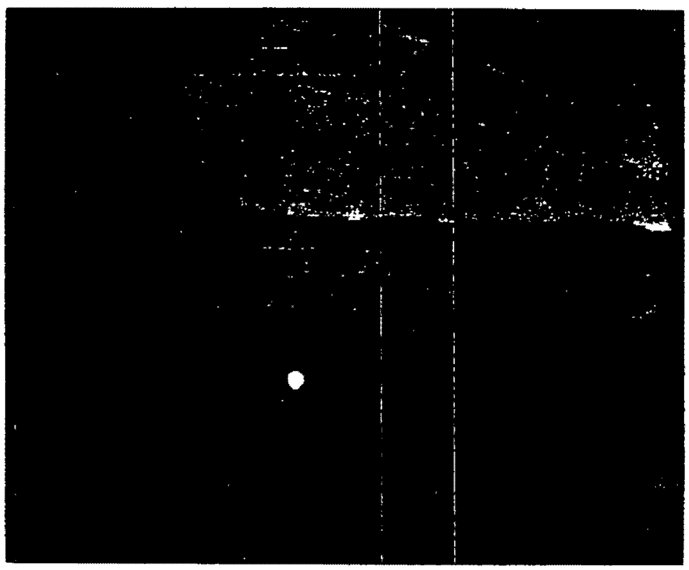
DATE APRIL 11,1990 **TIME** 10:15am **WEATHER** CLEAR

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 90°/N

FILM TYPE POLAROID **FRAME NO.** 3

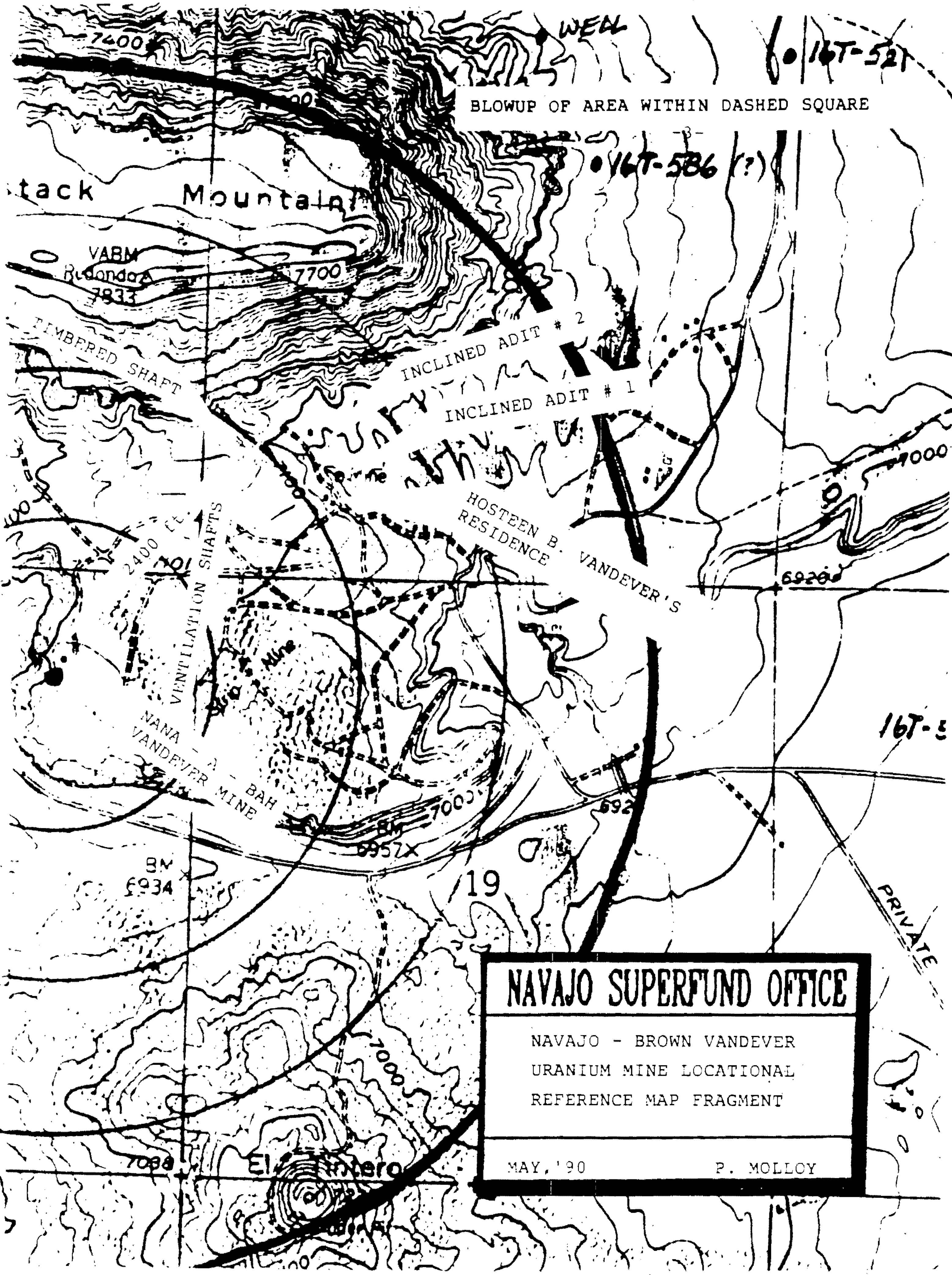
DATA TAKEN WITH PHOTOGRAPH: YES

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ______________
4. Radiation Survey (x)
   Reading: LUDLUM#19-7uR hr^{-1} :: ESP-II-7(10^3)cpm
5. Deep Well Water Sample ( )
6. Photograph Below: YES



3rd FR,

7. **DESCRIPTION** HAYSTACK AREA REFERENCE/BACKGROUND CHECK LOCATION, LOOKING N


WELL
16T-52T
BLOWUP OF AREA WITHIN DASHED SQUARE
-3-
16T-586 (?)
Mountain
VABM
7833
7700
7400
TIMBERED SHAFT
INCLINED ADIT # 2
INCLINED ADIT # 1
HOSTEEN B. VANDEVER'S RESIDENCE
2400 ft
VENTILATION SHAFTS
NANA - A - BAH VANDEVER MINE
7000
6926
BM 6957
BM 6934
19
PRIVATE
NAVAJO SUPERFUND OFFICE
NAVAJO - BROWN VANDEVER
URANIUM MINE LOCATIONAL
REFERENCE MAP FRAGMENT
MAY, '90
P. MOLLOY

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

DATE APRIL 11,1990 **TIME** 10:25am **WEATHER** CLEAR

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 20°/ENE

FILM TYPE POLAROID **FRAME NO.** 7

DATA TAKEN WITH PHOTOGRAPH: YES

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ______
4. Radiation Survey (x)
   Reading: LUDLUM#19-24uR.hr^{-1} :: ESP-II - 2.2(10^4) BACKGROUND @ B VANDEVER
5. Deep Well Water Sample ( )
6. Photograph Below: YES

7th FR.

7. **DESCRIPTION** TRENCH CUT NNE OF B. VANDEVER RESIDENCE LOOKING NE. NOTE FRAMES 8, 9, 10 TAKEN AT SAME LO-CATION

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

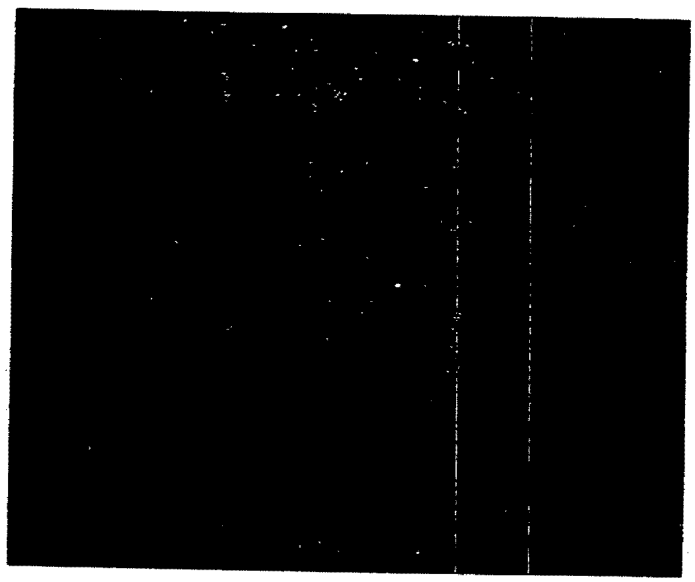
DATE APRIL 11,1990 **TIME** 10:25am **WEATHER** CLEAR

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 70°/NNE

FILM TYPE POLAROID **FRAME NO.** 8

DATA TAKEN WITH PHOTOGRAPH: YES, SEE FRAME 7

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ______________
4. Radiation Survey (X)
   Reading: ______________
5. Deep Well Water Sample ( )
6. Photograph Below: YES



8th FR.

7. **DESCRIPTION** TAILINGS FROM INCLINED ADIT IN FRAME 12, LOOKING NNE

NAVAJO SUPERFUND DEPART

FIT PHOTOGRAPH LOG SHEET

-5'-

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE**

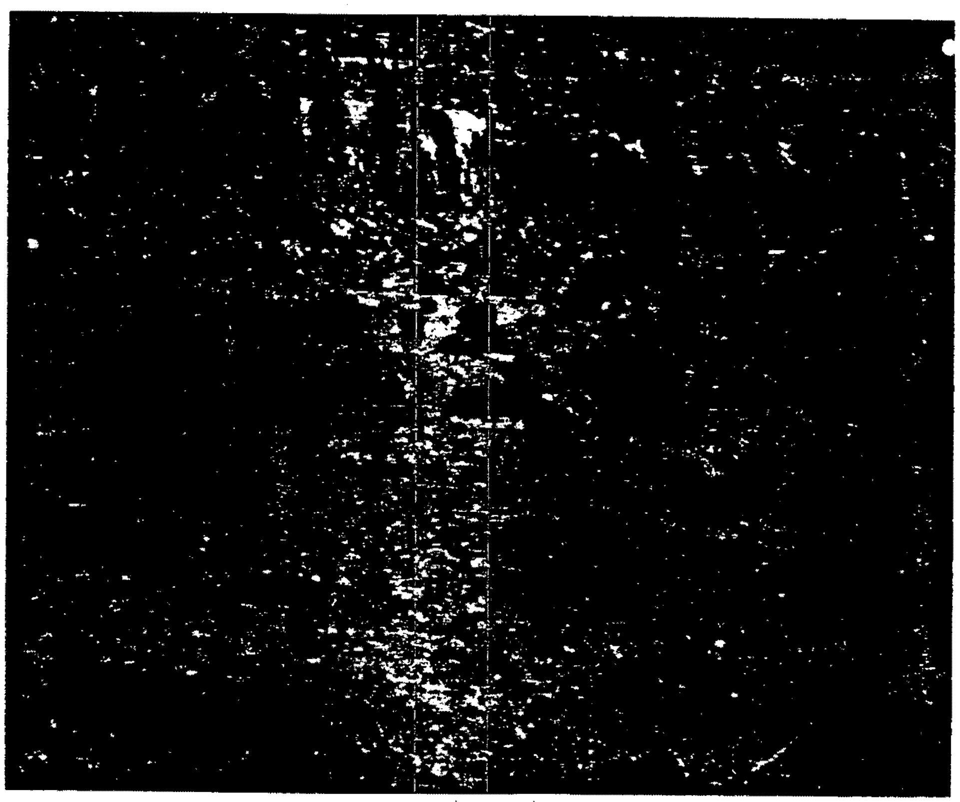
DATE APRIL 11,1990 **TIME** 10:25am **WEATHER** CLEAR

PHOTOGRAPHER P. MOLLOY **ANGLE/DIREC**

FILM TYPE POLAROID **FRAME NO.** 8

DATA TAKEN WITH PHOTOGRAPH: YES, SEE FRAME 7

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ____________
4. Radiation Survey (X)
   Reading: ____________
5. Deep Well Water Sample ( )
6. Photograph Below: YES



FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

DATE APRIL 11,1990 **TIME** 10:25am **WEATHER** CLEAR

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** [illegible]0°/NNW

FILM TYPE POLAROID FRAME NO. 12

DATA TAKEN WITH PHOTOGRAPH: YES

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ______
4. Radiation Survey (X)
   Reading: LUDLUM#19 - 21uR.hr^{-1} : @ FACE OF ADIT
5. Deep Well Water Sample ( )
6. Photograph Below: YES

12th FR.

7. DESCRIPTION INCLINED ADIT N OF B. VANDEVER RESIDENCE, LOOKING NNW

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

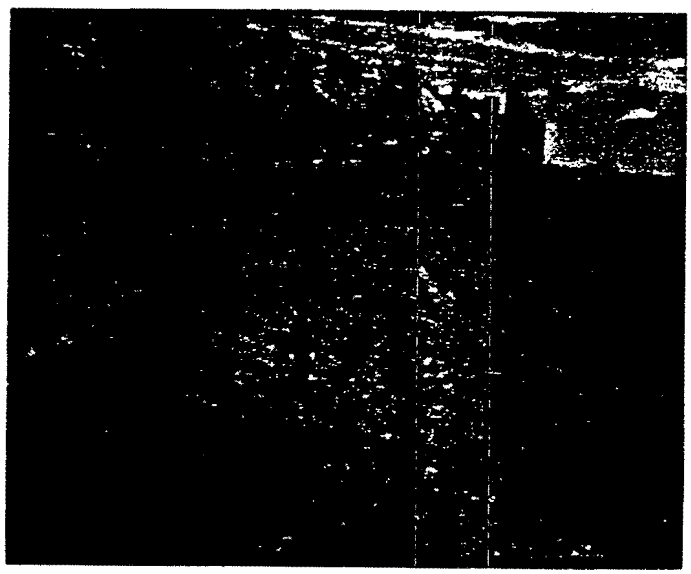
DATE APRIL 11,1990 **TIME** 10:25am **WEATHER** CLEAR

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 10°/N OF NNE

FILM TYPE POLAROID **FRAME NO.** 15

DATA TAKEN WITH PHOTOGRAPH: YES

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ____________
4. Radiation Survey (X)
   Reading: 350uR.hr-1(LUDLUM#19) : @ EDGE OF "LOADING BAY"
5. Deep Well Water Sample ( )
6. Photograph Below: YES



15TH FR.

7: **DESCRIPTION** TRENCH AT CENTER MIDDLEGROUND IS ORE "LOADING BAY", LOOKING N OF NNE

NAVAJO SUPERFUND DEPART

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE**

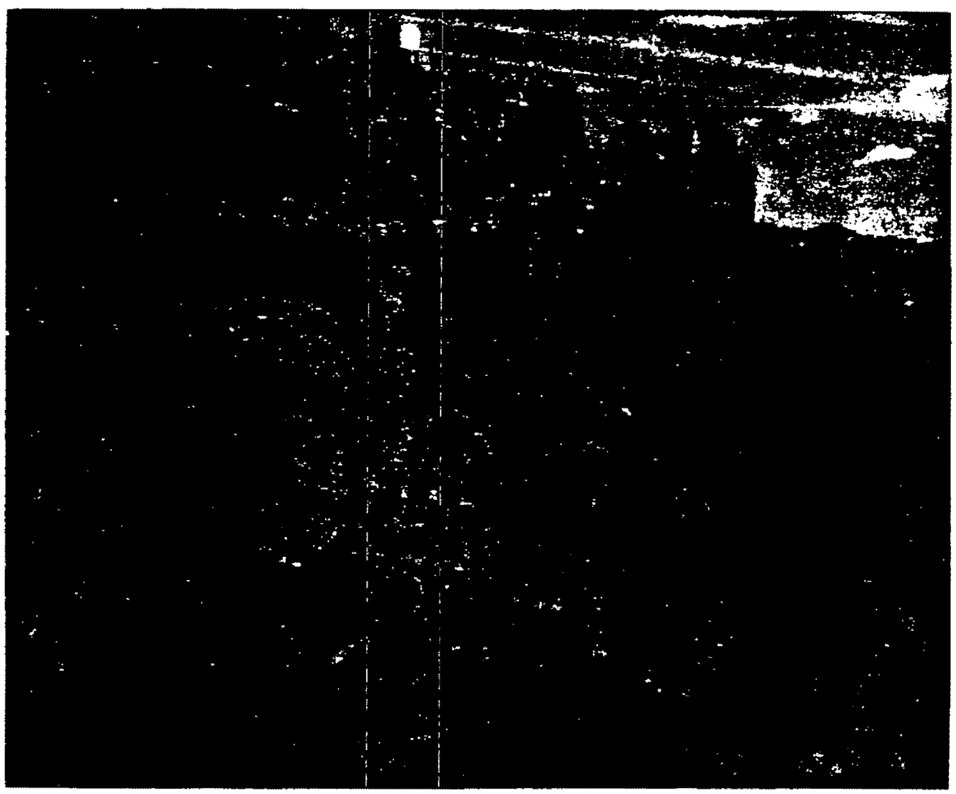
DATE APRIL 11,1990 **TIME** 10:25am **WEATHER** CLEAR

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECT**

FILM TYPE POLAROID **FRAME NO.** 15

DATA TAKEN WITH PHOTOGRAPH: YES

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ______
4. Radiation Survey (X)
   Reading: 350uR.hr^{-1}(LUDLUM#19) : @ EDGE
5. Deep Well Water Sample ( )
6. Photograph Below: YES



FIELD NOTES

PAGE#1

- 9TH FRAME - DRUM #27 (ELORIN)
□ KLEENGARD - KIMBERLY CLARK
* - MORE TEAR RESIST. THAN TYVEK

*** ◇ WHOLE BODY COUNTS ! ***

APRIL 11, 1990: B. VANDEVER MINE (HAYSTACK BUTTE AREA)
◇ @ NSO
- LUDLUM #19 - 7 μR.hr⁻¹
- ESP-II & RATEMETER ≃ 7(10³) CPM
◇ PREWITT SITE
- 2 FRAMES OF RECLAMATION WORK
◇ TURN OFF TO HAYSTACK BUTTE
○ BACKGROUND (LUDLUM #19)
- @ SHINE ~ 5 μR.hr⁻¹
- @ FACE ~ SAME
○ B'GRND (ESP-II
- @ SHINE ~ 6.5(10³) CPM:
FACE SAME
◇ od. RESET @ 17218.4 MI.
◇ 3RD FR. - REFERENT FRAME FOR B'GRND CHECK (NOTE EXTENSIVE SURFACE WORKS, RIGHT CNTR MIDDLE GROUND)
◇ 17220 (1.6)
○ 2 FRAMES OF RES. W OF HAYSTACK BUTTE
- 6TH FR. NOTE HAYSTACK B. IN MIDDLE GROUND AS REFERENT
ALSO WINDMILL

◇ 17220.9 (
-6TH FR
HAYSTAC
◇ 17222.4 (
-1 RES. &
◇ 17223.7
- BROWN
- 1 RES.
◇ 3 FRAM
-7TH FR.
-8TH FR
RES
-9TH FR
RZ.M
-10TH FR
◇ 1 FRAME
@ B. VAN
- B'GRND
○ LUDLU
○ ESP II
○ SHINE
○ SHINE

◇ 12TH FR.
◇ 13TH FR.
○ LUDLU
SHINE
◇ B. VANDE
- "STOPES
400 yd
** - "BORREGO

UM #27 (ELDRIN)
(BERLY CLARK
31ST. THAN

NTS ! ***

EVER MINE
AREA)

.hr-1
ER ≈ 7(10^3)cpm

ECLAMATION

TACK BUTTE
DLUM#19)
R.hr-1
E

3(10^3) cpm:

1218.4 mi.
EREHT FRAME
ECK (NOTE EXTEN-
ORKS, RIGHT CNTR

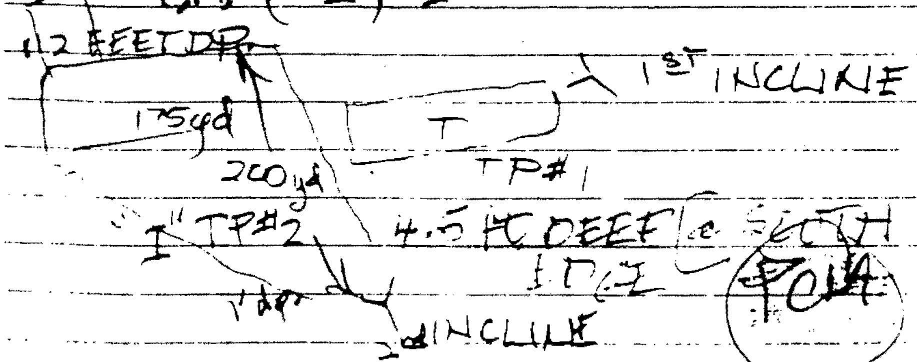
S. W OF HAYSTACK

HAYSTACK B. IN
S REFERENT

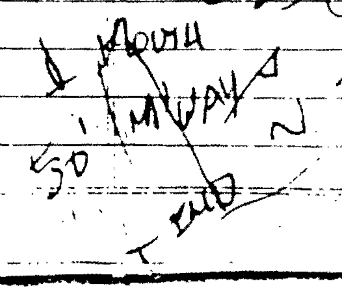
◇ 17220.9 (2.2 od.)
- 6TH FR. - RES. (2) W OF
HAYSTACK B.
◇ 17222.4 (3.7 od.)
- 1 RES. & CHURCH - NO PICTURE
◇ 17223.7 (5.0 od.)
- BROWN VANDEVER RES.
- 1 RES. @ THIS LOCATION
◇ 3 FRAMES
- 7TH FR. - TRENCH CUT
- 8TH FR - GOPHERINGS N OF
RES
- 9TH FR - REFERENT TSOH-
DZIL
- 10TH FR - MARTINEZ RES'S.
◇ 1 FRAME, REFERENT B'GRND
@ B. VANDEVER'S SONS RES.
- BKGND (11TH FR.)
- o LUDLUM #19 - 24 μR·hr^-1 (FAC
- o ESP II - 2.15(10^4) cpm (FACE)
- o SHINE - SAME
- o SHINE - 2.25(10^4) cpm
NOTE DRAINAGE INTO
◇ 12TH FR. - INCLINED ADIT
◇ 13TH FR. - TRENCH & RXR BED
o LUDLUM #19 - 21 μR·hr^-1 @
SHINE
◇ B. VANDEVER
- "STOPES ARE 400 yds (ESE),
400 yds (N)"
** - "BORREGO PASS MINE; 300' DP"

[redacted]

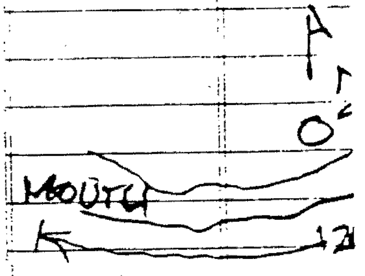
◇ TOP OF T.P. NE OF INCLINE
80 $\mu R \cdot hr^{-1}$
◇ ~~HOT~~ ROCK — .1 $mR \cdot hr^{-1}$
– 14TH FR.
◇ 350 $\mu R \cdot hr^{-1}$ @ LOADING "BAY" EDGE; 400 $\mu R \cdot hr^{-1}$ @ CTR (SHRINE) 650 $\mu R \cdot hr^{-1}$ (@ FACE), VANADATE OBSERVED
◇ 2nd INCLINE – FACE 160 $\mu R \cdot hr^{-1}$
◇ TAILINGS STREAM 200 yds x 175 yds APPROX. 1 foot dp., & 180 $\mu R \cdot hr^{-1}$ @ E EDGE OF T.P. (#2) "I"



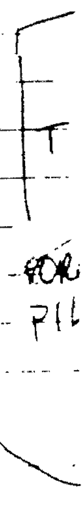
◇ 380 $\mu R \cdot hr^{-1}$ @ "II"
☆ 15TH FR – TP#2
★ 16TH FR – DRAINAGE (E)
□ IN DRAINAGE (E) AND S OF TP'S
– MOUTH – 5 (10^4) cpm
– MIDWAY – 6.5 (10^4)
– END – 3.25 (10^4)



J @ 100 : C
6.5 (10^4)
– 17TH FRA
– 18TH "
(E)
□ DRAINAGE



– 3.5 (10^4)



□ DUE S OF
– 20TH FR.
– 21ST FR.
LOOKING
□ DUE W OF
ED W/ TAIL
– 22nd FR EAC

E. OF INCLINE

.1 mR·hr^{-1}

LOADING "BAY"
hr^{-1} @ CTE (SHINE FACE), VANADATE

FACE 160 μR·hr^{-1}
/A 200 yds /
1 foot dp.'s
E EDGE OF

1ST INCLINE

#1

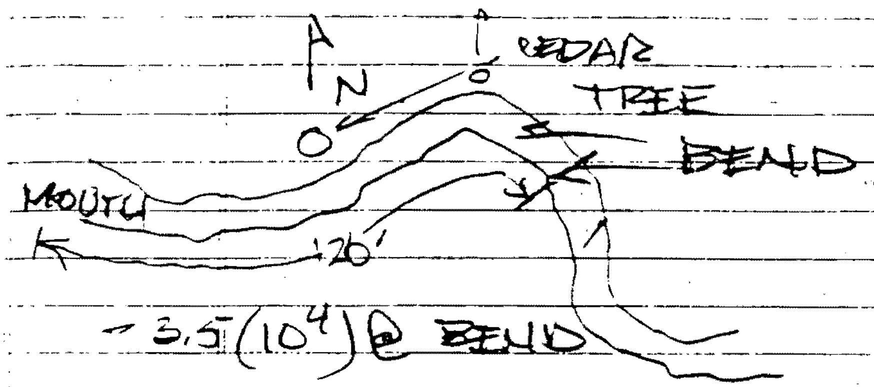
E

@ "II"

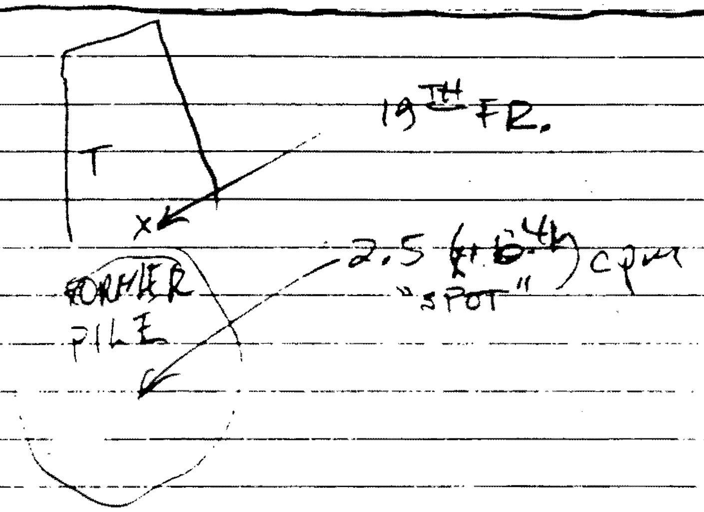
NAGE (E)
S OF TP's
m

J @ 100' : CEDAR TREE, IN DR.
6.5(10^4) cpm
-17th FRAME (COLOC. @ 6.5(10^4)
-18th " - DOWN DRAINAGE (E)

☐ DRAINAGE



-3.5(10^4) @ BEND



☐ DUE S OF MARTINEZ RES.
-20th FR. - STRAT. SECTION / HYSTK
-21st FR. - B. VANDERVER OUTFIT, LOOKING WSW

☐ DUE W OF B. VANDEVER ROAD GRAVELED W/ TAILINGS (ESP-II ~ 10^5 cpm)
-22nd FR. - LOOKING E, NOTE: MT. TAYLOR IN BACKGROUND AS REF.

[redacted]

[redacted]

- ESP II - 5.2 (10^4) cpm
- LUDLUM #19 - 100 µR.hr^{-1}

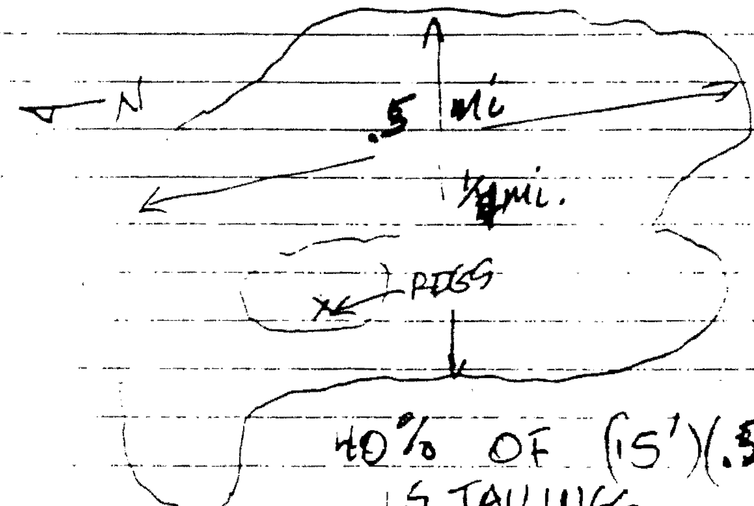
★ - NOTE: BOTH RDGS @ SHINE

☐ @ .8 mi. W OF B. VANDEVER RES.

- ~~NANA-A-BAH VANDEVER MINE?~~
- * FRAMES 23 AND 24

☐ @ EXTENSIVE SURFACE WORKS W. OF B.V. RESIDENCE

- FRAMES 25 THRU 28 - SEMI-PANORAMA



40% OF (15')(.5mi)(.25mi) IS TAILINGS

☐ @ OVERLOOK

- 29TH FR - LOOKING N, RES. IN CTR MIDDLEGROUND
- 30TH FR - LKG NW, WESTERN EXTENT OF SURFACE WORKS
- 31ST FR - LKG NE, EASTERN EXTENT OF SURFACE WORKS; NOTE TAILINGS FAR CENTER M'GRND

☐ @ TIMBERED INCLINE

- 33RD FR.

☐ 32ND FR. - LKG. SURFACE WORKS

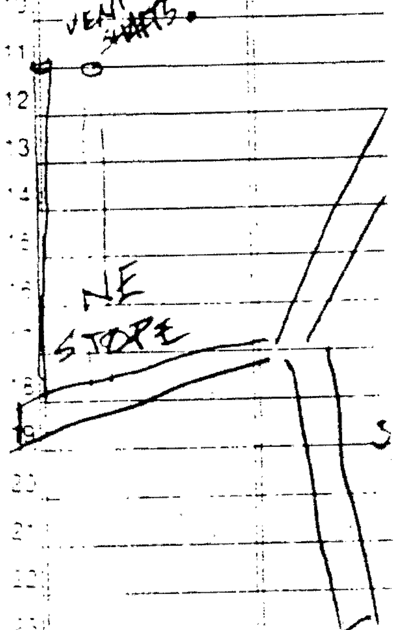
CONT'D @ T

- ESP-II
- LUD#19

★ B. VANDEVE

- "TIMB. S
- DRILLING
- "RXR L
- "B.V. -

1/4 SEC



★ @ DUE N

- 33RD FR.

~~[illegible]~~

- AND MR

☐ @ TURN OFF

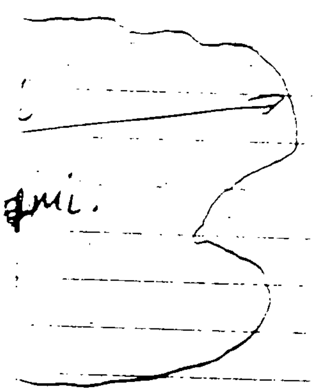
- 34TH FR

MINE (N

B'GRND

) cpm
00 μR·hr⁻¹
DGS @ SHINE
B. VANDEVER

VANDEVER MINE?
AND 24
FACE W. WORKS OF
ICE
THRU 28 - SEMI-

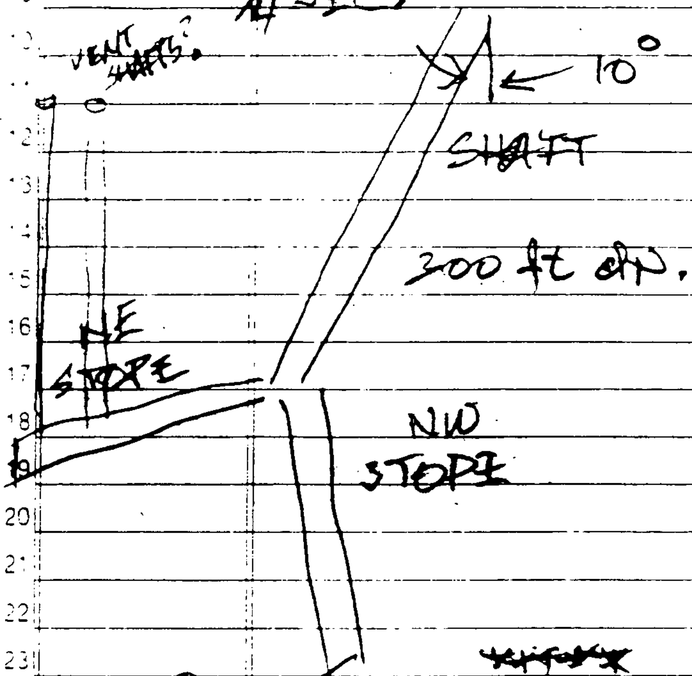


OF (15')(.5mi.)(.25mi.)
LLINGS

NG N, RES. IN
AND
NW, WESTERN EX-
CE WORKS
NE, EASTERN EX-
CE WORKS; NOTE
CENTER M'GRND
INE

SURFACE WORKS

CONT'D @ TIMB. SHAFT
- ESP-II - 10^4 cpm
- LUD#19 - 10 $\mu R \cdot hr^{-1}$
★ B. VANDEVER:
- "TIMB. SHAFT ~ 300 ft DEEP"
- "DRILLING (EXPL.) NNW OF SHAFT"
- "RXR LAND W & SE OF B.V."
- "B.V. - 1/4 SEC. 18, B.V. [illegible] 1/4 SEC."



~~XXX~~ @ DUE N OF SURFACE WORKS
- 33rd FR. - VENT. SHAFTS: VECTO[illegible]

- AND MR. BROWN VANDEVER
□ @ TURN OFF TO B.V.
- 34th FR - DRAINAGE E OF B.V. MINE (NOTE: MT. TAYLOR IN B'GRND AS REFERENT)

☐ @ DUE S OF H'STK B.
- 35TH FR. - ARTESIAN WELL USED FOR STOCK WATER AND ?
☐ @ DUE E OF H'STK B.
- FRAMES 36 THRU 39 - HAYSTACK COMMUNITY/ RES'S.
- FRAME 40 SAA
☐ @ WELL 16T-552
- DIP, VAT, & TANK - 41ST FR
- WELL NOT FUNCTIONING
☐ BACK TO THE B.S. GRINDER
• • • •

APRIL 12, 1990: STF. MTG.
☐ WABOS, WABOS, WABOS, WABOS
☐ LEE BIGWATER
- "WIFE IS LAB S'VISOR @ SAGE MEM."
☐ LTL SPOKE (TECH. STF GOT STUCK AGAIN)
○☆ CHRIS PETRE :: WILL BRING,
- HNO_3, NALGENE 2 L, 500 ml, 8-OZ. SOIL SAMPLE JARS, DL, COND. METERS
- STAY IN FARMINGTON? JEG FOR CHRIS P.
○ CIBOLA MED. $262
☐ CHECK OUT VEH. FROM BEVERLY NEZ
☐ GET TA B4
☐ "BOYS" AGAIN
○☆ MONTHLY REPORT - APRIL 27, 1990
NSD :: NEPA SAME
◇ OMB: "REG. IX - LEAD AGENCY"
* ◇ CEQ: IS MANDATED TO DO THIS

LOUISE? HOLA

6. From frames 25 through 32 (Ref#3) and page #5 of Ref #14 field notes (sketch of area) the following dimensions are obtained;

$L=2640ft.$

and

$w=1320ft.$ utilize the geometric mean of these two values to compute the area:

$r=((2.64(10^3))(1.32(10^3)))^{\frac{1}{2}}$ ft.

$=1867$ft. so that

$A\simeq \pi r^2=1.1(10^7)ft^2$

$=251$ acres

7. Assume that 50% of this area is covered with tailings with a mean height of 2.5 ft: The corresponding volume computes to be;

$V_{geo}=(.5)(1.1(10^7))(2.5)ft^3.$

$=1.38(10^7)ft^3.$

8. Compensate this volume for void volume overestimate to find

$.7V_{geo}=9.63(10^6)ft^3$

9. Assume that the fraction of U_3O_8 within the tailings is the order of 10^{-4}whereby,

$V_{u3o8}\simeq 9.36(10^2)ft^3=2.73(10^7)cm^3.$

10. Apply the density of 23.26 gm.cm to the above volume to find

$M_{u3o8}=6.35(10^5)kg.$

$:700.1$ tons

11. Combining quantities from 10. above and the previously obtained value of $2.63(10^4)$ kg. and utilizing the empirical u:v ratio from reference #____2____find

$$\frac{M_{u3o8}}{M_{v2o5}}\simeq\frac{.19}{.30}$$

solving for M_{v2o5} find

$M_{v2o5}=1.579\ M_{u3o8}$

$=1.579(6.613(10^5))kg$

$=1.04(10^6)kg$

12. Combining totals for M_{v2o5} and M_{u3o8} find

$M_{v2o5}+M_{u3o8}=1.7(10^6)kg$

$:1880.3$ tons

Resulting in hazmat QF of 7

NAVAJO SUPERFUND OFFICE

BROWN VANDEVER URANIUM MINE

MAY '90 P. MOLLOY

Number	Mine Name	Tons Ore	Pounds U_3O_8	$\%U_3O_8$	Pounds V_2O_5	$\%V_2O_5$	Type of Deposit	Host Rock	Periods of Production/ Shipper
13N.9W.20.321	Mesa Top Mine	100,261	512,965	0.24	144,610	—	sandstone	Jmp	1954-1957 - Lee Explora 1957-Holly Minerals an
13N.10W.4.244	Pat - Section 4 (Dakota Mine)	5,069	12,645	0.12	2,470	—	sandstone	Jmw,Kd	1952-1959 - Dakota Mini Co.; 1962-1963-Farris Mines, Inc.
13N.9W.19.420	[1]Poison Canyon	217,066	1,004,574	0.23	338,094	—	sandstone	Jmp	1952-1959 - Haystack Mc Development Corp.; 196 1962-Farris Mines Inc.
14N.11W.28.113	Red Cap Group (T Group)	195	497	0.13	951	0.24	limestone	Jt	1952-1953 - Navajo Deve ment Co.; 1953-Fitzhug Doerrle
13N.10W.16.134	Red Point Lode	482	1,223	0.13	746	0.07	limestone	Jt	1952-1955 - R.M. Shaw
14N.11W.28.144	Red Top Mines	165	390	0.12	1,207	0.39	limestone	Jt	1955 - Red Top Uranium Mining Co.
14N.9W.34.424	[1]Sandstone	1,034,255	3,540,829	0.17	—	—	sandstone	Jmw	1959-1963 - Phillips Petroleum Co.; 1963-19 United Nuclear Corp.
13N.9W.1.200	[1]Section 1 (13N-9W) mined through Cliffside	148,066	1,699,137	0.57	—	—	sandstone	Jmw	1967 - Kerr-McGee; 1969 Kerr-McGee and Nation
15N.16W.3.332	Section 3 (15N-16W) Santa Fe-Christensen Rats Nest Mine	324	1,836	0.28	404	—	sandstone (coal)	Kd	1957 - Christensen and Uranium Co.; 1957-1958 Uranium Co.
13N.10W.5.144	Section 5 (13N-10W)	23	54	0.12	—	—	sandstone	Kd	1958 - Westvaco
13N.9W.8.114	Section 8 (13N-9W) Spencer Shaft	47,800	165,319	0.17	—	—	sandstone	Jmp	1958-1960 - United West 1961-Hyde and Casper; 1966-W.D. Tripp; 1966- James J. Goode
14N.10W.10.244	[1]Section 10 (14N-10W)	130,767	510,935	0.20	—	—	sandstone	Jmw	1957-1962 - Kermac Nucl 1964-Homestake-Sapin
14N.10W.12.411	[1]Section 12 (14N-10W)	74,975	211,873	0.14	—	—	sandstone	Jmw	1961 - Anderson Develop Corp.; 1962-1963-Stell Dysart
14N.10W.15.441	[1]Section 15 (14N-10W)	1,213,814	3,625,924	0.15	—	—	sandstone	Jmw	1958-1961 - Homestake-Sa 1961-1965-Rio and Homestake-Sapin; 1966-1969-Homestake-Sapin; 1969-1 United Nuclear-Homestak
14N.9W.17.323	[1]Section 17 (14N-9W)	544,164	2,315,182	0.21	—	—	sandstone	Jmw	1960-1964 - Kermac Nucle Corp.; 1965-1970-Kerr-M
13N.10W.18.341	Section 18 (13N-10W) (Indian Allotment)	25,796	98,175	0.19	75,342	0.30	limestone	Jt	1952 - Sutton, Thompson, Williams; 1953-Williams 1955-Santa Fe Uranium 1956-Santa Fe Uranium a Federal Uranium; 1957-1 Federal Uranium; 1963-1 Mesa Mining Co.; 1966-C Mining Co.
14N.9W.18.400	[1]Section 18 (14N-9W) mined through Sec. 17	501,946	1,586,447	0.16	—	—	sandstone	Jmw	1962-1964 - Kermac Nucle 1965-1970-Kerr-McGee
14N.9W.20.114	[1]Section 20 (14N.9W) mined through Sec. 17	486,375	2,223,977	0.23	—	—	sandstone	Jmw	1962 - Kerr-McGee
14N.10W.22.223	[1]Section 22 (14N-10W)	2,189,851	11,605,672	0.18	—	—	sandstone	Jmw	1958-1964 - Kermac Nucle 1965-1970-Kerr-McGee
	heap leach	—	30,105	—	—	—			
14N.10W.23.134	[1]Section 23 (14N-10W)	2,528,797	9,679,773	0.19	—	—	sandstone	Jmw	1959-1968 - Homestake-Sa 1969-1970-Homestake-Uni Nuclear
13N.10W.23.444	Section 23 (13N-10W)	21,826	130,541	0.32	10,256	0.06	limestone	Jt	1957-1965 - Haystack Mou Development Corp.; 1965 1966-Santa Fe Pacific
13N.9W.24.121	Section 24 (13N-9W) Chill Wills, Rialto (Section 13)	10,950	37,693	0.17	—	—	sandstone	Jmp	1960-1963 - Febco Mines,
13N.11W.24.222	Section 24 (13N-11W) Indian Allotment to Nana-A-Bah Vandever	24,638	115,075	0.22	85,545	0.18	limestone	Jt	1952-1954 - Glen William 1955-1956-Santa Fe Uran 1955-Federal Uranium Co Santa Fe Uranium; 1956- Federal Uranium Corp.
14N.10W.24.332	[1]Section 24 (14N-10W)	1,904,582	7,071,564	0.19	—	—	sandstone	Jmw	1959-1964 - Kerr-McGee Nuclear; 1965-1970-Kerr-McGee
	Heap leach	—	579	—	—	—			
13N.10W.25.411	[1]Section 25 (13N-10W)	235,156	950,058	0.20	153,657	0.12	limestone	Jt	1952 - A T and SF RR; 19 1961-Haystack Mountain velopment Corp.; 1962-1 Santa Fe Pacific; 1963- Farris Mines, Inc.; 196 1965-Santa Fe Pacific; 1966-Farris Mines, Inc. 1968-Homestake; 1969-19 United Nuclear Corp.
14N.10W.25.144	[1]Section 25 (14N-10W)	1,791,048	6,444,889	0.18	—	—	sandstone	Jmw	1959-1969 - Homestake-Sa 1969-1970-Homestake-Uni Nuclear
13N.10W.26.221	[1]Section 26 (13N-10W) Oseldero Group	11,110	83,752	0.38	17,510	0.08	limestone	Jt	1952-1957 - Hanosh Mines
14N.10W.26.220	[1]Section 26 (14N-10W) mined through Section 24	362,110	1,190,696	0.17	—	—	sandstone	Jmw	1965-1970 - Kerr-McGee

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

DATE APRIL 11,1990 **TIME** AFTERNOON **WEATHER** CLEAR

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 315°/ESE

FILM TYPE POLAROID **FRAME NO.** 25

DATA TAKEN WITH PHOTOGRAPH: *** NONE ***

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ______________
4. Radiation Survey (X)
   Reading: ______________
5. Deep Well Water Sample ( )
6. Photograph Below: YES

25TH Fr

7. **DESCRIPTION** WESTERN EXTENT OF SURFACE WORKS WSW OF B. V. RESIDENCE, LOOKING ESE

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

DATE APRIL 11,1990 **TIME** AFTERNOON **WEATHER** CLEAR

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 350°/E OF ES

FILM TYPE POLAROID **FRAME NO.** 26

DATA TAKEN WITH PHOTOGRAPH: *** NONE ***

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ____________
4. Radiation Survey (X)
   Reading: ____________
5. Deep Well Water Sample ( )
6. Photograph Below: YES

26TH Fr

7. **DESCRIPTION** SURFACE WORKS WSW OF B. V. RES., LOOKING E OF ESE; NOTE MT. TAYLOR IN FAR LEFT BACKGROUND AS REFERENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

DATE APRIL 11,1990 **TIME** AFTERNOON **WEATHER** CLEAR -HIGH HAZY CLOUDS

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 20°/E OF ENE

FILM TYPE POLAROID **FRAME NO.** 27

DATA TAKEN WITH PHOTOGRAPH: YES, NOT WRITTEN DOWN

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ______
4. Radiation Survey (X)
   Reading: 150uR.hr-1(LUDLUM#19),10^4cpm(ESP-II)
5. Deep Well Water Sample ( ) *** APPROXIMATE ***
6. Photograph Below: YES

27 94 FR

7. **DESCRIPTION** SURFACE WORKS WSW OF B. V. RES., SEE FOLLOW-ING SKETCH, LOOKING E OF ENE

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

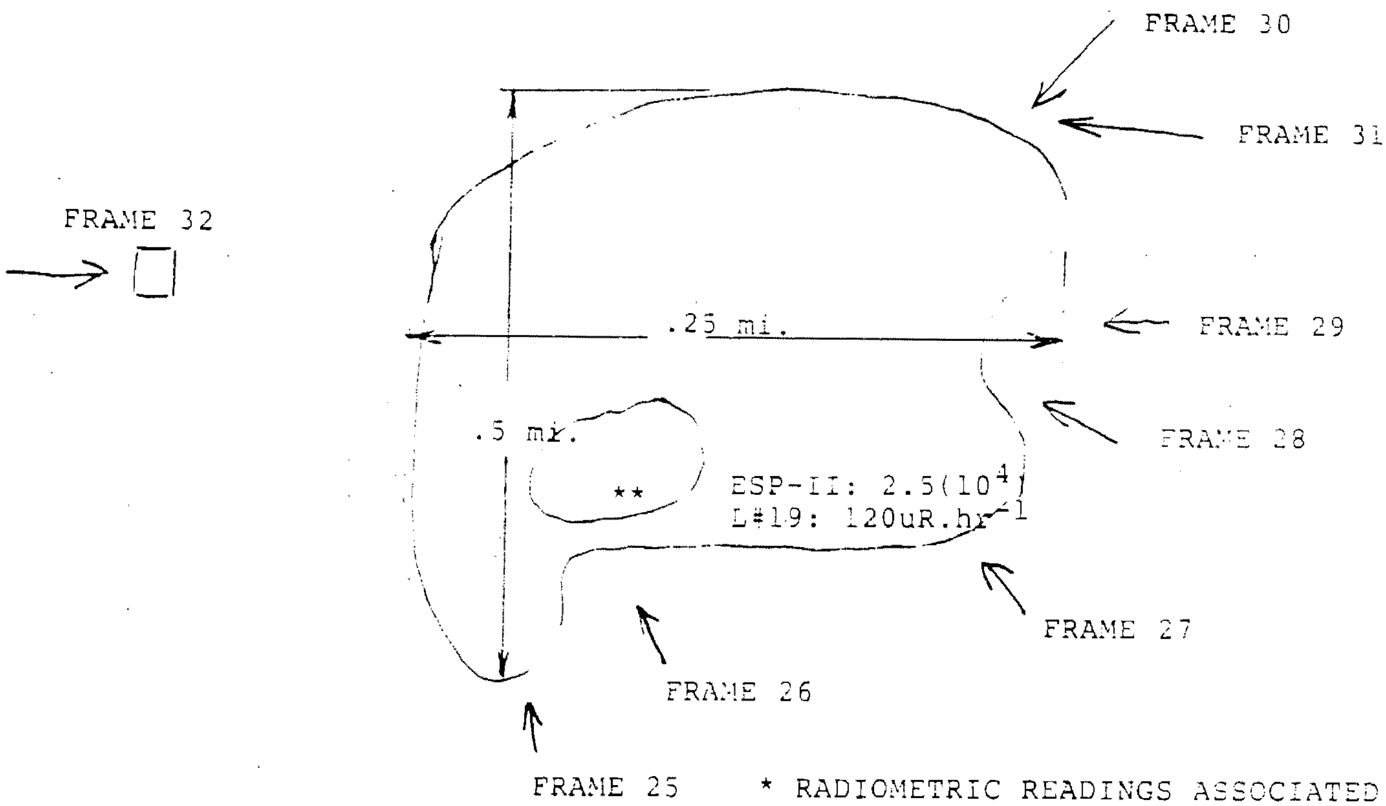
DATE APRIL 11,1990 **TIME** 11:15am **WEATHER** CLEAR TO SLIGHTLY OVERCAST

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** -

FILM TYPE POLAROID **FRAME NO.** NO FRAME

DATA TAKEN WITH PHOTOGRAPH: SKETCH

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ______
4. Radiation Survey (X)
   Reading: SEE BELOW
5. Deep Well Water Sample ( )
6. Photograph Below: *** NONE ***



* RADIOMETRIC READINGS ASSOCIATED WITH FRAME 27

7. **DESCRIPTION** SKETCH OF AREA WHERE RADIOMETRIC READINGS WERE TAKEN, NO SCALE

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

DATE APRIL 11,1990 **TIME** ________ **WEATHER** CLEAR

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** ________

FILM TYPE POLAROID **FRAME NO.** 28

DATA TAKEN WITH PHOTOGRAPH: *** NONE ***

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ________
4. Radiation Survey (X)
   Reading: ________
5. Deep Well Water Sample ( )
6. Photograph Below: YES, SEE SKETCH

RES. UNCLT
POM

3 RES.

28th Fr.

7. **DESCRIPTION** SEE SKETCH

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

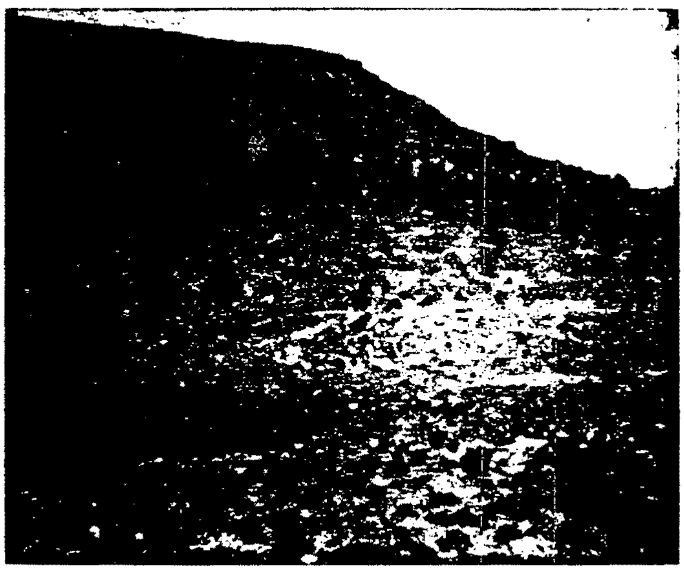
DATE APRIL 11,1990 **TIME** 11:15am **WEATHER** CLEAR TO SLIGHTLY OVERCAST

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** SEE SKETCH

FILM TYPE POLAROID **FRAME NO.** 29

DATA TAKEN WITH PHOTOGRAPH: *** NONE ***

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ______________
4. Radiation Survey ( )
   Reading: ______________
5. Deep Well Water Sample ( )
6. Photograph Below: YES



29TH FR.

7. DESCRIPTION ______________________

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

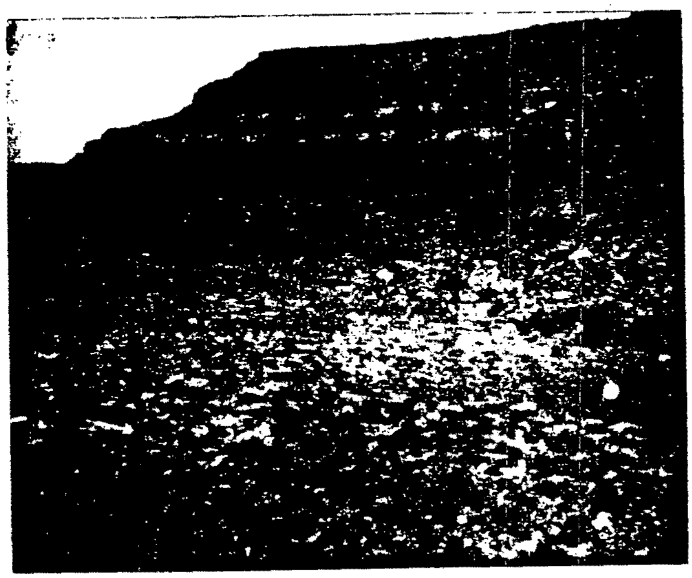
DATE APRIL 11,1990 **TIME** 11:15am **WEATHER** CLEAR TO SLIGHTLY OVERCAST

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** SEE SKETCH

FILM TYPE POLAROID **FRAME NO.** 30

DATA TAKEN WITH PHOTOGRAPH: *** NONE ***

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ________
4. Radiation Survey (X)
   Reading: ________
5. Deep Well Water Sample ( )
6. Photograph Below: YES



30 $^{\mathrm{IH}}$ EK.

7. DESCRIPTION ________

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

DATE APRIL 11,1990 **TIME** 11:15am **WEATHER** CLEAR TO SLIGHTLY OVERCAST

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** SEE SKETCH

FILM TYPE POLAROID **FRAME NO.** 31

DATA TAKEN WITH PHOTOGRAPH:

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ______________
4. Radiation Survey (x)
   Reading: ______________
5. Deep Well Water Sample ( )
6. Photograph Below: YES

31ST FR.

7. DESCRIPTION ______________________________

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

-17-

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

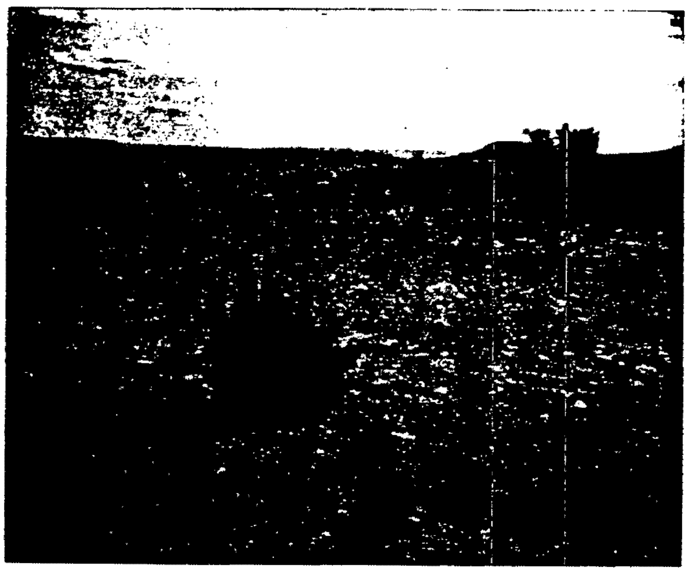
DATE APRIL 11,1990 **TIME** 2:30pm **WEATHER** CLEAR TO SLIGHTLY OVERCAST

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** SEE SKETCH

FILM TYPE POLAROID **FRAME NO.** 32

DATA TAKEN WITH PHOTOGRAPH: *** NONE ***

1. **Soil Sample** ( )
2. **Surface Water Sample** ( )
3. **Air Monitoring Device** ( )
   Reading: ________________
4. **Radiation Survey** (X)
   Reading: ________________
5. **Deep Well Water Sample** ( )
6. **Photograph Below:** YES



32 @ FR. rKG S

7. DESCRIPTION ____

13. From page #6 (Ref #14) of field notes, direct quote of Mr. B. Vandever, "Timbered shaft is approximately 300 feet deep" and the personal observation that the shaft is approximately 5 feet square. The following surface area computation obtains;

$$S = 4((5ft.)(300ft.)) = 6,000 ft^2.$$

It is assumed that the timbered shaft was not the primary shaft, but was a shaft driven for both mining and ventilation purposes to connect with the Nana-a-bah Vandever mine which is approximately 2400 ft. Southest of the timbered shaft.

14. From page #6 of field notes (Ref #14), direct quote of Mr. B. Vandever and page #2 of field notes, direct quote of Mr. B. Vandever, "stopes are approximately 400 yds ESE and N", the observational fact that there are two inclined adits and the assumption that the inclines are 300 ft. deep the following surface area computation obtains;

$$S_{IA} = S_{A1} + 2S_S + S_{A2} = 2(S_{A1} + S_S)$$

or

$$S = 2((4)(5ft.)(5ft.)(300ft.) + (4)(5ft.)(5ft.)(1200ft.) = 3.0(10^5) ft^2.$$

15. Combining the results of calculations 13. and 14. find;

$$S_T = S_{TS} + S_{IA} = 3.06(10^5) ft^3 : 8.665(10^3) m^2 = 7.02 \text{ acres}$$

16. From frame #22 (Ref #3) and field notes (Ref #14) pages #4 and #5, gamma ratemeter/ESP-II reading on the "hot road" was

$$\varphi = 10^5 \text{ cpm}.$$

Assume that this quantity is attributable to Bi^{214} activity exclusively and that the following relationship is true

$$\varphi = CV_0 \int_0^e (K(.61 \text{ Mev})\Psi.61 + K(1.76\text{Mev})\Psi1.76)dt.$$

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

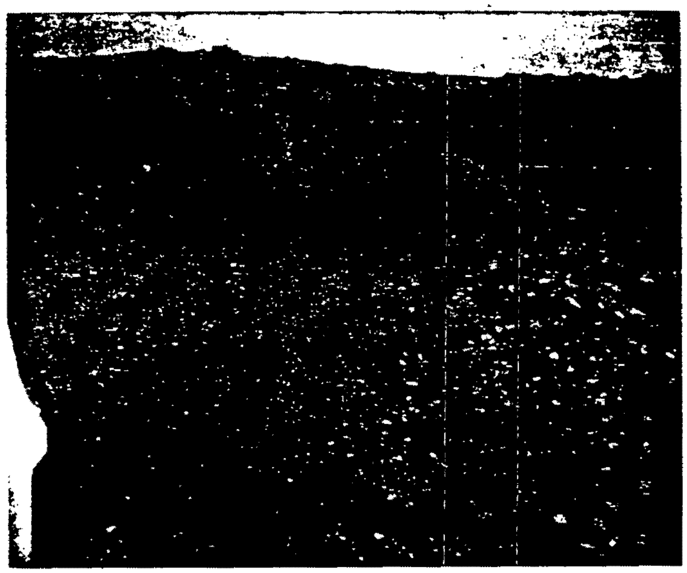
DATE APRIL 11,1990 **TIME** AFTERNOON **WEATHER** CLEAR

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 0°/E

FILM TYPE POLAROID **FRAME NO.** 22

DATA TAKEN WITH PHOTOGRAPH: YES

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading:
4. Radiation Survey (x)
   Reading: 10^5cpm(ESP-II) @ EDGE OF ROAD
5. Deep Well Water Sample ( )
6. Photograph Below: YES



22nd #r,

7. **DESCRIPTION** "HOT ROAD" WEST OF B. V. RESIDENCES, SURFACE WORKS WASTE PILES @ RIGHT MIDDLEGROUND, MT. TAYLOR @ UPPER LEFT BACKGROUND AS REFERENT

GEOCHEMISTRY OF URANIUM

I. Atomic Chemistry of Uranium

A. Atomic Number: 92, heaviest naturally occurring element.

B. Atomic Weight: 238.03

C. Naturally Occurring Isotopes

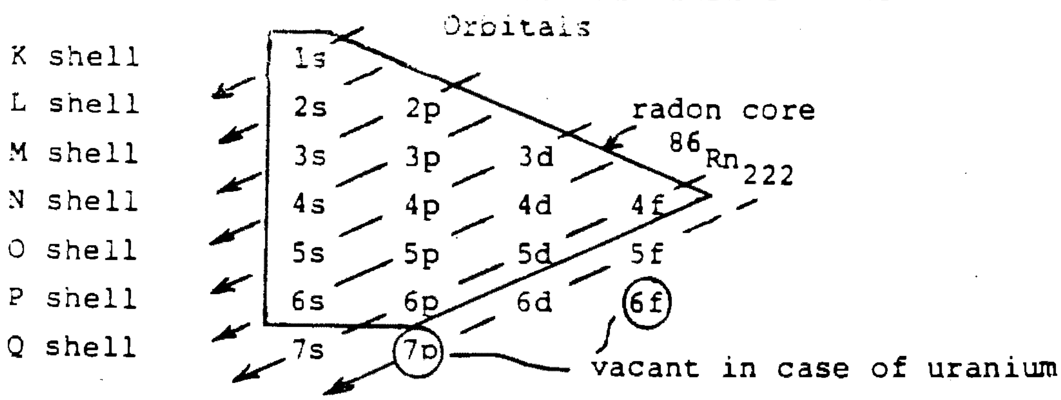
Mass No.	Abundance Wt. %	Activity % (radioactive decay events per unit of time)
238	99.28	48.9
235	0.71	2.2
234	0.0054	48.9

D. Nuclear Properties

1. All isotopes of uranium are radioactive.
2. U-235 is readily fissionable.
3. All isotopes of all elements above Bismuth (83) are radioactive.

Isotope	Half Life
U^{238}	4.51×10^{9} years
U^{235}	7.1×10^{3} years
U^{234}	2.48×10^{5} years

E. Electronic Structure and Valence States



2. Energy of decay process often results in oxidation, therefore U^{234} may be U^{+6} from U^{238} in UO_2 (uraninite) Note: U^{238} and U^{235} always in fixed ratio in nature.

VI. Measurement of Nuclear Radiation

A. Alpha (α) radiation measured by

1. proportional counters (gross α radioactivity)

2. semiconductor detectors, for α energy spectrometry

3. photographic techniques (track etch) radon α particularly

4. helium analysis with mass spectrometer

B. Beta (β) radiation

1. measured with proportional counter

2. not very useful, except for ore grade control

C. Gamma (γ) radiation

1. Because of high range and discrete energy levels, most frequently measured radiation

2. Geiger counter

a. inexpensive, measures total γs from all sources, non energy selective

b. γs enter gas-filled tube, ionize gas, giving electrical impulse

3. Scintillation counter

a. medium resolution γ energy spectra

b. medium cost $2000 - 20,000

c. γ strikes NaI crystal, converts energy to light. Sorts light intensity for different energies

4. Semiconductor detector (germanium)

   a. high resolution γ spectra

   b. high cost

D. Uranium Analysis by Gamma Spectrometry

1. U^{238} series

   a. U^{238}, U^{235}, U^{234} γ energies are too low for practical measurement

   b. Bi^{214}, daughter in U^{238} series, has γ energies of 0.61 MeV and 1.76 MeV which are readily measured. Figure 28.

   c. Bi^{214} is good measure of Rn^{222}

   d. Bi^{214} activity is reliable measure of U^{238}-U^{235} activity only if sample has not weathered for 1 million years, and radon has not escaped for 3 weeks

   e. Bi^{214} is the mechanism of "radiometric assaying" for uranium

2. Th^{232} series

   a. Tl^{208} daughter has high energy 2.615 MeV γ (Figure 29)

   b. Th^{232} analysis by measuring Tl^{208} activity because short-lived daughters

   c. Some Th^{232} series γs interfere with 1.76 MeV γ from Bi^{214}, so need to know Th content when measure Bi^{214} activity

3. K^{40} gamma spectrum

   a. high energy 1.46 MeV γ (Figure 30)

4. Superimpose U^{238}, Th^{232}, and K^{40} γ spectra

   a. 2.615 MeV, Tl^{208} from Th^{232}

   b. 1.76 MeV, Bi^{214} from U^{238}

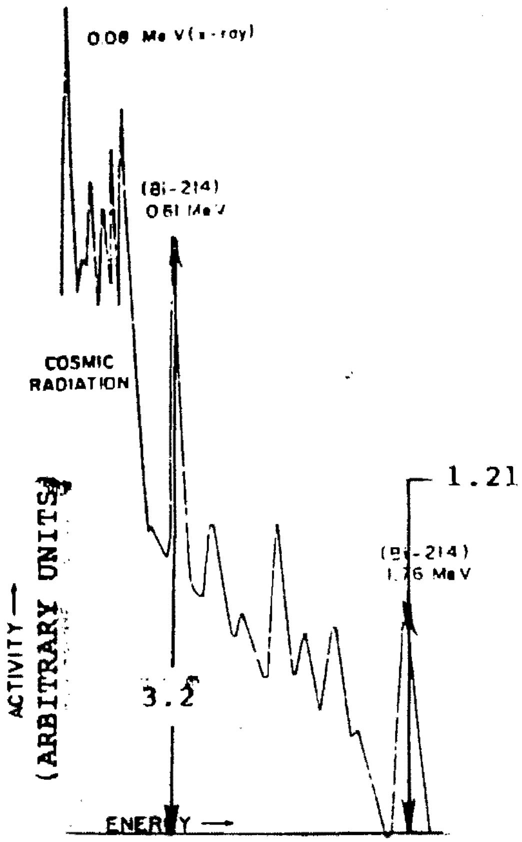


Fig. 28. Gamma spectrum of equilibrium U-238, U-235 series.

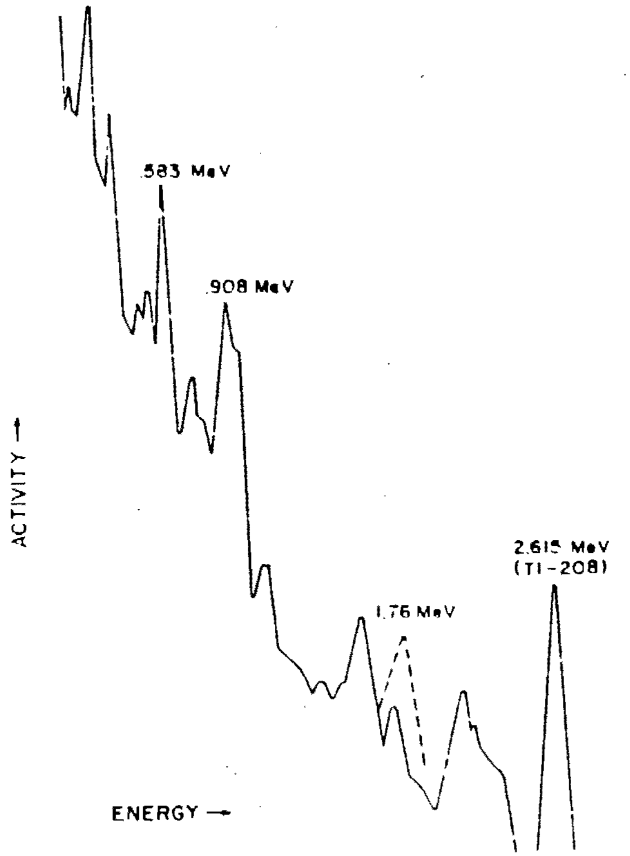


Fig. 29. Gamma spectrum of equilibrium Th-232 series.

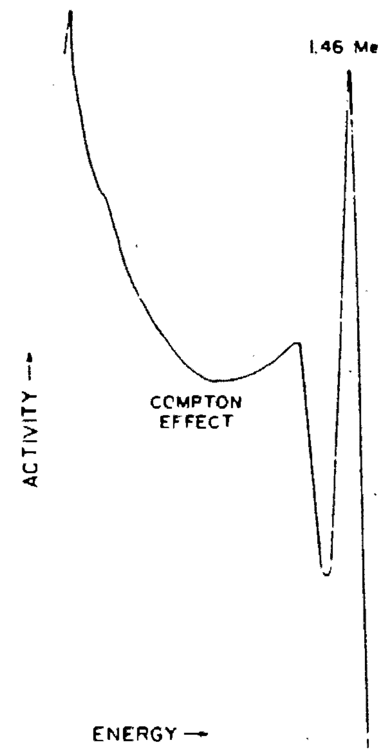


Fig. 30. K-40 gamma spectrum.

Where the integral is taken over the convolution "capture window" interval of the NaI(Tl) detector. Assume that the kernels of the convolution K(.61 Mev) and K(1.76 Mev) are equal and of unit amplitude. Further assume that the instrument response factor C is unity.

From page #40 of reference # 10 ,figure #28, the ratio of the amplitudes of production is;

$$\frac{\Psi_{.61}}{\Psi_{1.76}} \simeq \frac{3.2}{1.21} \qquad \text{(Arbitrary units)}$$

It then follows that

$$\Psi_{.61} = 2.645\,\Psi_{1.76}$$

and inversely. Recognize that the Ψ, are proportional to the number of B^{214} atoms present at the grab site. Calculate the volume of the NaI detector as follows:

$$V_D = \frac{\pi\,(5.1\text{cm})^2}{2}\,(5.1\text{cm})$$
$$= 104.183\ \text{cm}^3.$$

Compute the integral as follows;

$$\text{since } 10^5 = 10^2 \int_0^e 1.3784\,\Psi'_{.61}\,dt.$$

Consider that $\Psi_{.61}$ is constant during the interval and that the instrument capture window time constant is 100 msec., then

$$10^3 = 1.378\,\Psi'_{.61}\Delta t$$
$$= 1.378(10^{-1})\,\Psi'_{.61}$$

Solve for $\Psi'_{.61}$ to obtain $\Psi'_{.61} = 7.26(10^3)$.

Set the above quantity equal to the number of Rn^{222} atoms (per cubic centimeter) present at the grab site, eg.,

$$N(Rn\,222) \simeq 10^4$$

Given that the gamma ratemeter reads 10^5 cpm.

OTHER SPECIFICATIONS

Dimensions: 5.0 inches high × 5.0 inches wide × 10.25 inches long (12.7 cm × 12.7 cm × 26.0 cm)
Temperature Range: -4°F to +122°F (-20°C to +50°C)

Weight: 4.1 pounds (1.86 kg)
Connectors: MHV for detector input, 9-pin "D" shell female connector for RS-232C communication

---

DETECTOR PROBES RECOMMENDED FOR USE WITH ESP-2

Model No.	Type Measurement	Useful Range with ESP-2	5 Percent*
HP-270	Exposure or Exposure Rate	Bkg to 3000 mR/h	1 to 3000 mR/h
HP-290	Exposure or Exposure Rate	0.0005 to 80 R/h	0.01 to 80 R/h
HP-210L HP-260	Beta-Gamma Contamination	Bkg to 100,000 counts/s	14 to 100,000 counts/s
AC-3	Alpha Contamination	Bkg to 50,000 counts/s	14 to 50,000 counts/s
NRD	Neutron Dose Equivalent or Dose Equivalent Rate	0.001 to 60 rem/h	0.02 to 60 rem/h
LEG-1	Low Energy Gamma or x-ray	Bkg to 50,000 counts/s	14 to 50,000 counts/s
SPA-3	High Sensitivity Gamma	Bkg to 50,000 counts/s	14 to 50,000 counts/s
SPA-6	Medium Sensitivity Gamma	Bkg to 50,000 counts/s	14 to 50,000 counts/s

*Ratemeter mode provides 5 percent, or better, standard deviation readout capability over the indicated range.

ACCESSORIES

Audio Headset: Part No. ADHS4

Any of the following Eberline detectors can be used with the ESP-2:

Detector Probe	Cable	Check Sources	Probe Holder/Bracket
AC-3	CA-12-60	CS-1, CS-10, CS-12, CS-15	
HP-190A	CA-16-60	CS-7A	ZP10434029
HP-210AL	CA-16-60	CS-13	
HP-210L	CA-16-60	CS-13	
HP-210T	CA-16-60	CS-13	
HP-220A	CA-16-60		
HP-260	CA-16-60	CS-13	ZP10434029
HP-270	CA-16-60	CS-7A	ZP10434029
HP-280	CA-15-36		
HP-290	CA-16-60		ZP10434029
LEG-1	CA-12-60		
NRD	CA-15-60		ZP11292020
PG-2	CA-12-60		
SPA-3	CA-12-60	CS-7B	ZP10465017
SPA-6	CA-15-36	CS-7B	ZP10465017
SPA-8	CA-15-36	CS-7B	
SPA-9	CA-15-36	CS-7B	ZP10465017

Model SPA-3, Scintillation Probe

GENERAL DESCRIPTION

The Model SPA-3 scintillation probe is a rugged, waterproof gamma detector designed for high sensitivity of pulse-height applications.

The SPA-3 contains a 2-inch-diameter, 2-inch-long NaI(Tl) crystal, a 2-inch, 10-stage photomultiplier tube, tube socket with a dynode resistor string, and a magnetic shield.

SPECIFICATIONS

Crystal: NaI(Tl), 2-inch-diameter × 2 inches long (5.1 cm × 5.1 cm).

Photomultiplier Tube: ≅2-inch-diameter, 10-dynode, end-window with S-11 photocathode.

Operating Voltage: Variable dependent upon application.

Maximum Voltage: +1600 V

Sensitivity: ≅1200k cpm per mR/h with ^{137}Cs

Current Drain: ≅120 MΩ resistance string yields 10 μA at 1200 V.

Wall Material: Aluminum

Wall Thickness: 1/8-inch (0.32 cm), 1/16-inch (0.16 cm) at crystal

Connector: Mates with Eberline CP-1

Finish: Enameled body with chrome-plated connector

Size: 2 5/8-inch-diameter × 11 1/8 inches long (6.7 cm × 28.3 cm)

Weight: 3.25 pounds (1.5 kg)

AVAILABLE ACCESSORIES

Instruments	Cables
ASP-1	CA-12-60
ESP-1	CA-12-60
ESP-2	CA-12-60
ESP-2/PHA	CA-12-60
MS-2	CA-12-60
RM-20	CA-12-60
RM-21	CA-12-60
RM-23	CA-12-60
SAM-2	CA-12-60
SRM-100	CA-12-60
SRM-200	CA-12-60
SRM-200PHA	CA-12-60

Eberline
A subsidiary of Thermo Instrument Systems Inc.

P.O. Box 2108
Santa Fe, New Mexico 87504-2108
(505) 471-3232 TLX: 66-0438 EIC SFE
Telecopy: (505) 473-9221

GENERAL ASSUMPTIONS

1. Take $\rho ss \simeq 1.7\ gm.cm^{-3}$

Consider the U^{235} and U^{238} abundances (U^{234} negligible) whereby,

"Fraction U^{235}" = $7.2\ (10^{-3})$

"Fraction U^{235}" = .9927

Then derive the molecular weight of U_3O_8 as;

$$MWu_3o_8 = [7.2\ (10^{-3})]\ [(3)\ (235)] + (.9927)\ (3)\ (238)] + 8\ (16) = 821.86$$

Likewise, derive the molecular weight of SiO_2 (sandstone).

$$MWSiO_2 = 28.09 + 2\ (16) = 60.89$$

$$\frac{MWu_3o_8}{MWSiO_2} = \frac{821.86}{60.09} = 13.68$$

Then,

$$\frac{\rho u_3o_8}{\rho ss} = \frac{\rho u_3o_8}{1.7} = 13.68$$

So that,

$$\rho u_3o_8 \simeq 23.26\ gm.cm^{-3}$$

2. (From reference #22)

$$MWu^{235} = 235\ gm.\ .mole^{-1}$$

$$MWu^{238} = 238\ gm.\ .mole^{-1}$$

Yet, the atomic volume associated with ${}_{92}U^{235}$; periodic properties of elements

$$A_v = 12\ cm^3\ .mole^{-1}$$

whereby,

$$A_v^{-1}\ MWu^{235} = 19.58\ gm.cm^{-3}$$

and,

$$A_v^{-1}\ MW_u 238 = \rho u^{238} = 19.83\ gm.cm^{-3}$$

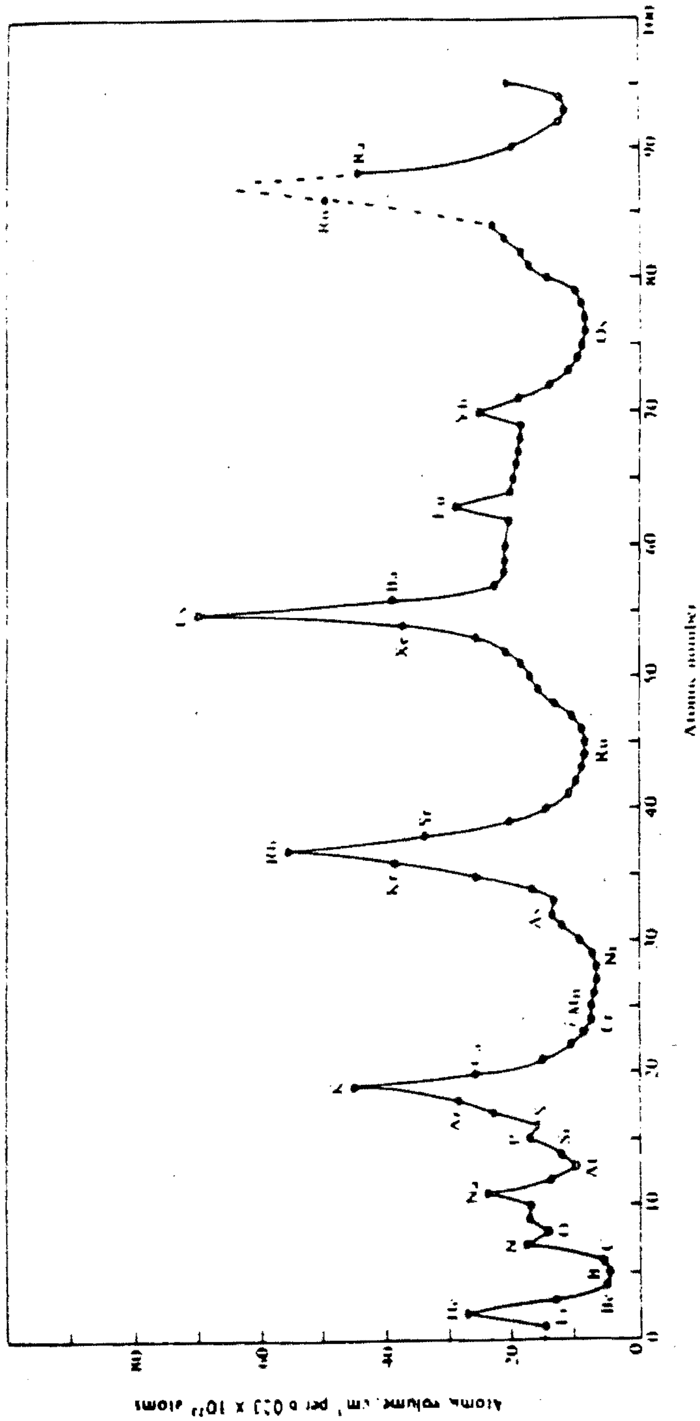


Figure 1-1 Atomic Volumes

PERIODIC PROPERTIES OF ELEMENTS

NAVAJO SUPERFUND OFFICE

GENERAL ASSUMPTIONS

MAY, '90 P. MOLLOY

Upgradient drainage area calculation

$A_T = A_1 + A_2 = 1.59 \text{ in}^2,$

However map fragment is a 141% blowup of part of bluewater quad, then

$2.64'' = 1$ mi.
or,
$1'' = .379$ mi.
$= 2000$ ft.

It then follows that for a 141% boost

$1'' = 1418 \text{ ft.} = \frac{2000}{1.41}$

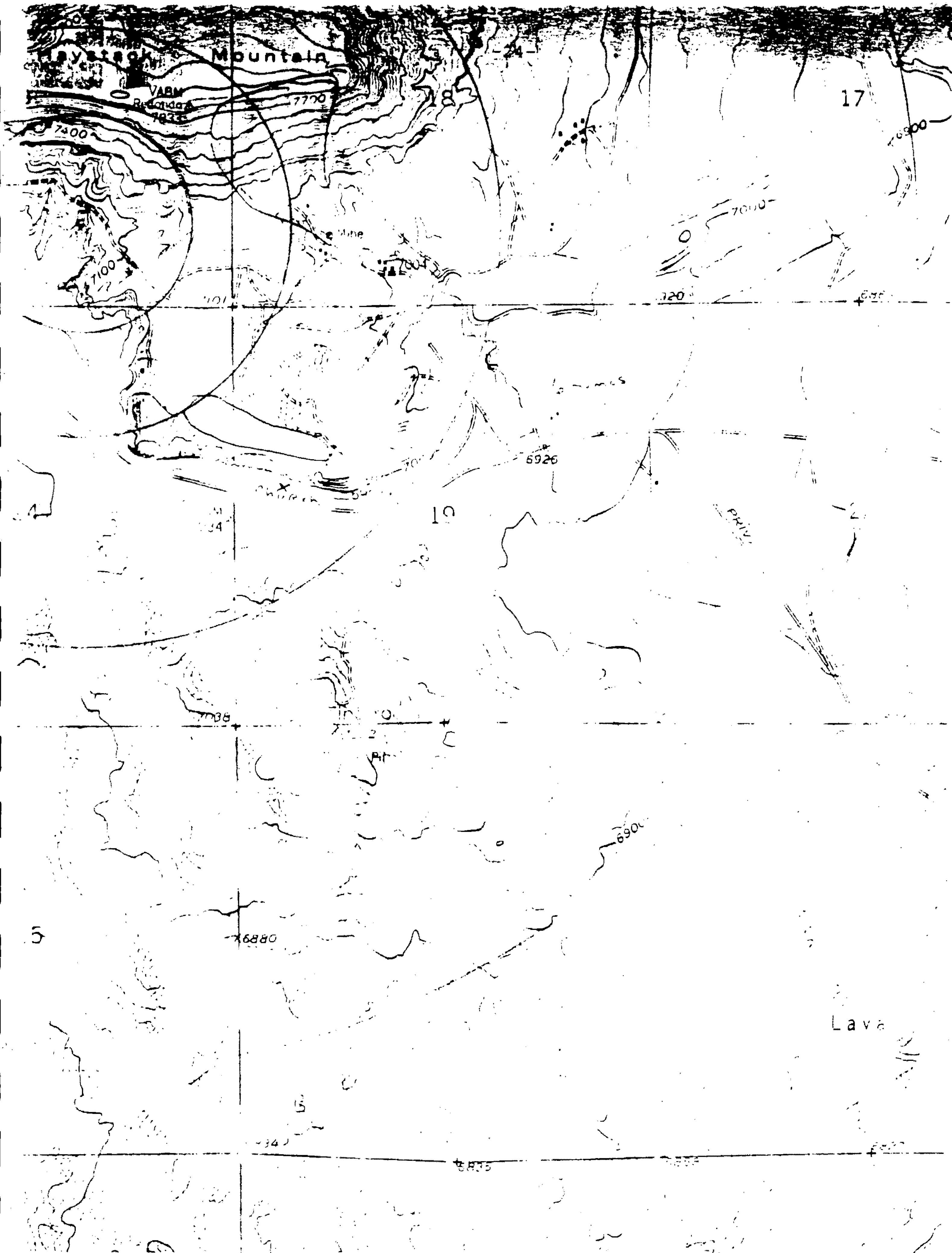
and

$A_T = 1.59(1.418(10^3)\text{ft.})^2$
$= 3.197(10^6)\text{ft}^2$
$= 73.39$ acres

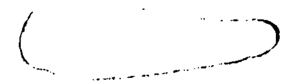
NAVAJO SUPERFUND OFFICE

BROWN VANDEVER URANIUM MINE
WORKSHEET#1

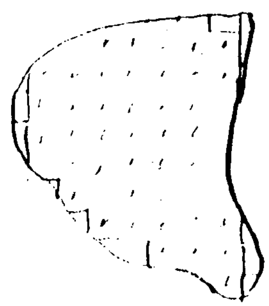
MAY, '90 P. MOLLOY



Haystack Mountain
VABM
7700
7400
7100
18
17
24
6900
7000
Mine
6926
19
PRIV
7038
6900
6880
5
Lava



A_1



A_2

11 □'s
9 △'s = 2 □'s
12 TOTAL

43 □'s
卌 II
50 TOTAL

$A_1 \propto 12$ □'s

$\square = (.64)^2\left(\frac{1"}{4}\right)^2 = .026\,in^2$

$\Rightarrow A_1 = .31\,in^2$

$A_2 \propto 50$ □'s

$\Rightarrow A_2 = 1.28\,in^2$

WORKSHEET#2; ALTERNATE COMMUNITY POPULATION DERIVATION

1. FROM THE "AS BUILT" FOR THE HAYSTACK COMMUNITY WATER SYSTEM THE FOLLOWING QUANTITIES ARE DEDUCED;

$$N_{res} = 86,$$

$$N_{prv} = 2$$

SO THAT,

$$N_{SERV} = 86 - 2 = 84$$

2. FROM REFERENCE#31(NAVAJO NATION FAX '88), THERE ARE 5.14 PERSONS PER NAVAJO HOUSEHOLD(AVERAGE) SO THAT;

$$N_p = (5.14)(N_{SERV}) = 432 \text{ PERSONS}$$

3. IT IS ESTIMATED THAT THERE ARE AT LEAST 100 PERSONS IN THE AREA THAT ARE NOT CONNECTED TO THE NNWRD WATER SYSTEM.

NAVAJO SUPERFUND OFFICE

NAVAJO-BROWN VANDEVER URANIUM MINE

JUNE,'90 P. MOLLOY

Worksheet for population total, population distribution and population at risk from noncertified water source.

Bracket	Res.	Pop.	*Res.	#Pop.	
0-¼	7	36	0	0	
¼-½	0	0	0	0	
½-1	12	62	3	15	
1-2	29	149	6	31	
2-3	24	123	2	10	
3-4	6	31	3	15	
	78	401	15	71	TOTALS

Potential
*Non-Certified water consumers

38. HAROLD PLATERO
39. LEON JOHNSON
40. PATRICIA JIM
41. MARTIN MARTINEZ

MARY DESIDERIO
JOHNNY KENNETH
82. BOYD MARTINEZ

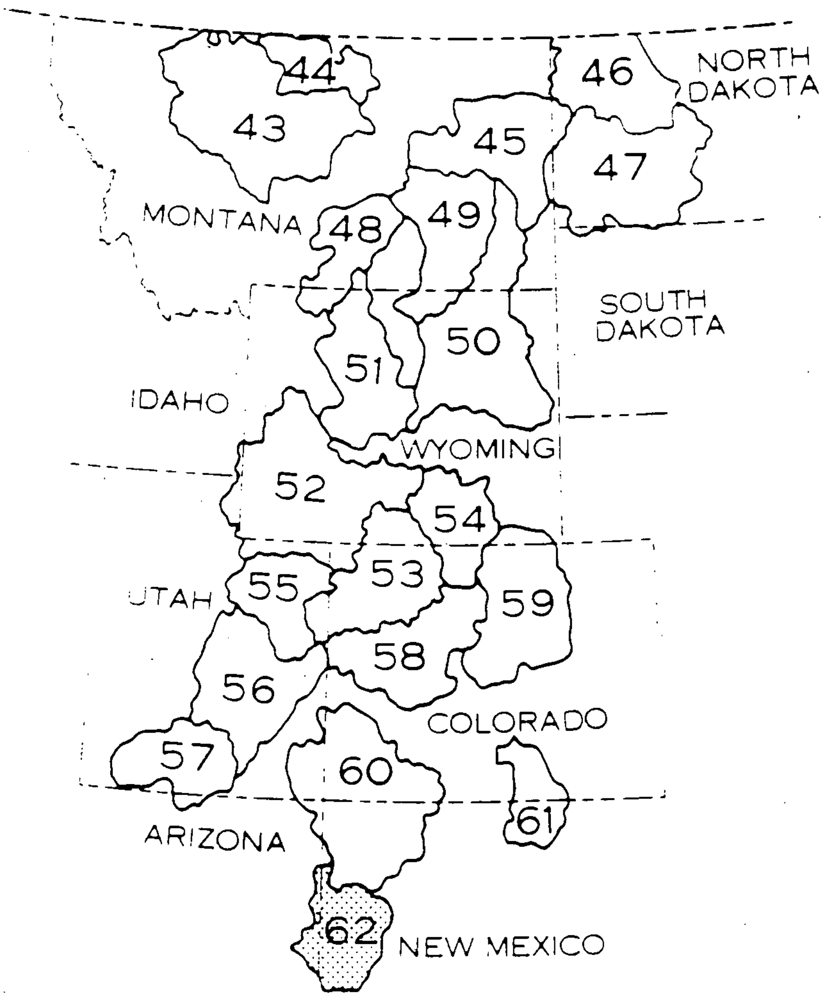
REFERENCE # 5

NAVAJO SUPERFUND OFFICE

BROWN VANDEVER URANIUM MINE REFERENCE MATERIAL

MAY, '90 R. MOLLOY

HYDROLOGY OF AREA 62, NORTHERN GREAT PLAINS AND ROCKY MOUNTAIN COAL PROVINCES, NEW MEXICO AND ARIZONA



- PUERCO RIVER
- ZUNI RIVER
- LARGO CREEK
- CARRIZO WASH
- RIO SAN JOSE
- BLACK CREEK

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

WATER-RESOURCES INVESTIGATIONS
OPEN-FILE REPORT 83-698

HYDROLOGY OF AREA 62, NORTHERN GREAT PLAINS AND ROCKY MOUNTAIN COAL PROVINCES, NEW MEXICO AND ARIZONA

BY
F. E. ROYBAL, J. G. WELLS, R. L. GOLD, AND J. V. FLAGER

U.S. GEOLOGICAL SURVEY

WATER-RESOURCES INVESTIGATIONS
OPEN-FILE REPORT 83-698

ALBUQUERQUE, NEW MEXICO
APRIL, 1984

CONTENTS

Land-Ownership Pattern is Complicated

Indian, Federal, and private ownership is represented.

As shown in figure 2.1-1, the land-ownership pattern in Area 62 is complicated. The checkerboard pattern created by several types of ownership makes it difficult to effectively manage these lands and consequently complicates the water rights. Indian ownership includes trust and deeded lands, but these categories are not identified on the map. Three Indian reservations are located entirely or partly within Area 62: the Navajo Reservation in New Mexico and Arizona, the Zuni and Acoma Reservations in New Mexico.

Federal land in Area 62 is administered by the U.S. Forest Service, the U.S. Bureau of Land Management, the National Park Service and the U.S. Department of Defense. Parts of Cibola and Apache National Forests are included in the New Mexico part of Area 62. El Morro National Monument is administered by the National Park Service. Fort Wingate Military Reservation, east of Gallup, New Mexico, is administered by the Department of Defense.

State and private lands are generally scattered in a checkerboard pattern. In the early 1850's, the Santa Fe Railroad received government grants for alternate sections of land in strips to build railroads in vacant and sparsely settled sections of the area. These grants created a checkerboard pattern of land ownership (Lower Colorado Region State-Federal Interagency Group for the Pacific Southwest Interagency Committee, Appendix VI, 1971, p. 56). Most of the privately owned lands are within Cibola County, New Mexico. In New Mexico, State lands are administered by the Commissioner of Public Lands with assistance from other agencies such as the State Park Commission, the State Forestry Commission, the State Department of Game and Fish, the State Engineer Office, and the State Department of Transportation.

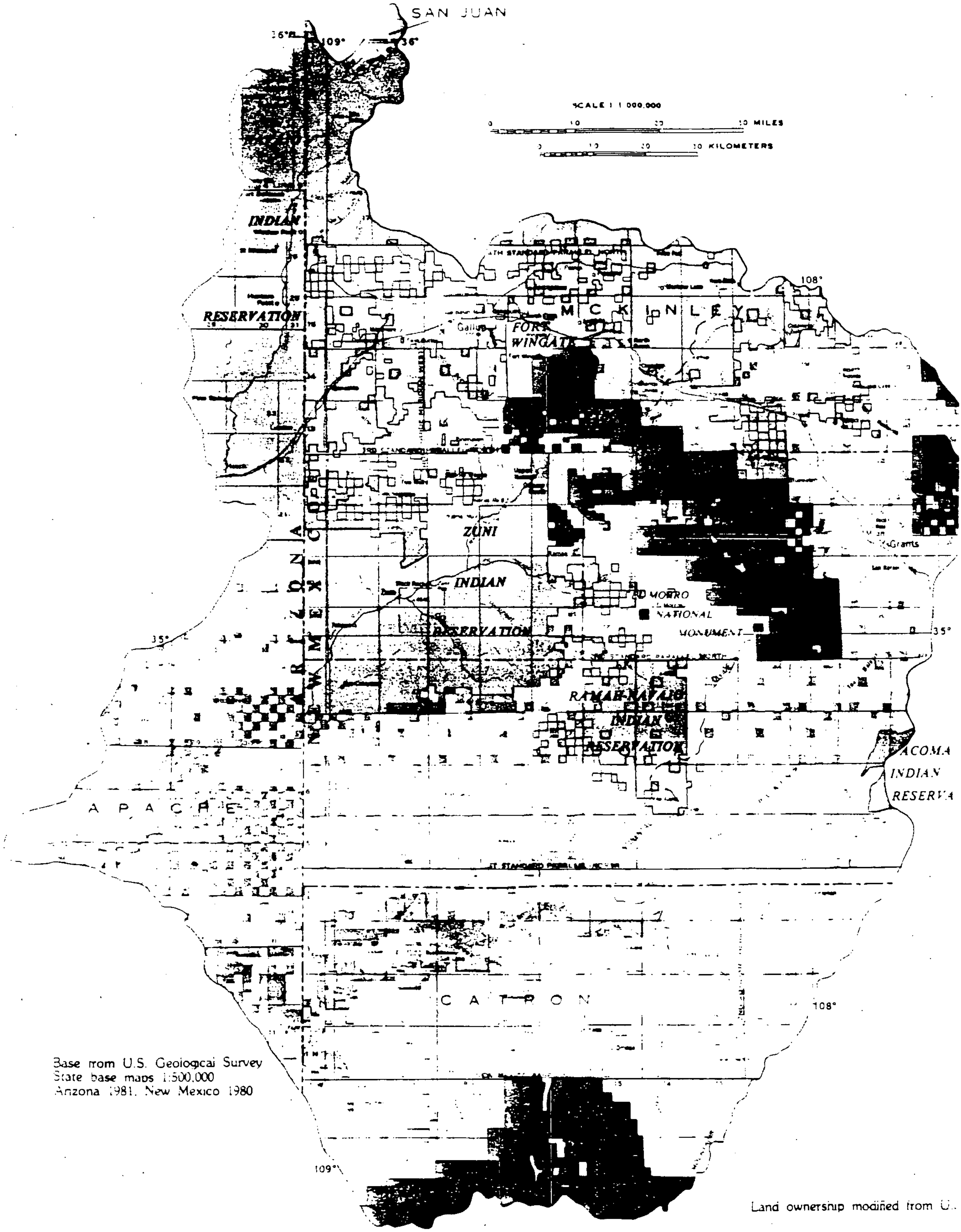


Figure 2.1-1 Generalized land ownership.

EXPLANATION

INDIAN LANDS

U.S. FOREST SERVICE

U.S. BUREAU OF LAND MANAGEMENT

NATIONAL PARK SERVICE

U.S. DEPARTMENT OF DEFENSE

STATE TRUST AND DEEDED

PRIVATE

...mation (1968) and U.S. Department of Agriculture (1981a).

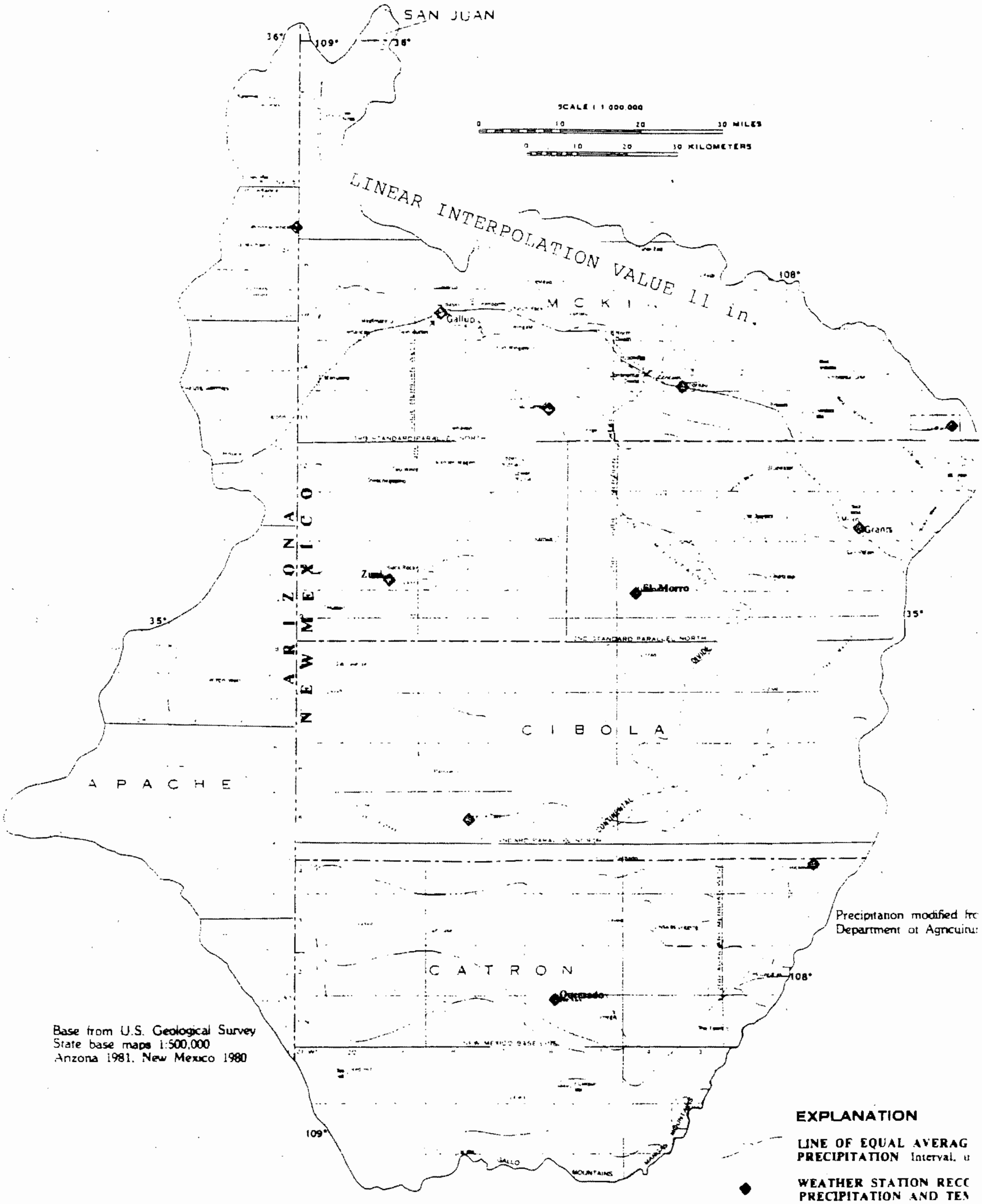
Average Annual Precipitation is 10 to 12 Inches in the Valleys and Plateaus and 16 to 20 Inches in the Mountains

Temperatures generally are warmest in July and coolest in January.

The climate is semiarid (about 10 to 20 inches of annual rainfall), except for a few isolated areas that receive more than 20 inches of precipitation per year. The variation in precipitation and temperature is controlled by altitude. Areas at high altitude have greater precipitation and lower temperatures than areas at lower altitudes. The approximate areal distribution of average annual precipitation is shown in figure 2.2-1. Average annual precipitation from long-term records are available for three stations: 12.34 inches at El Morro, 11.33 inches at Zuni, and 9.24 inches at Quemado. The distribution of average monthly precipitation for these three stations is shown in figure 2.2-2. The wettest months generally are July and August and the dryest months are generally May and June. During the winter, snowfall is common; a total of about 50 inches was recorded at McGaffey, New Mexico, in December 1967.

In Area 62, winters are rather cold, summers are warm, and days are sunny. Daily temperatures vary by 30 to 40 degrees. Temperatures greater than 90 degrees are not common in most of the area, but at Gallup, the maximum recorded was 99 degrees; the minimum was 23 degrees below zero (Tuan and others, 1973, p. 193). The distribution of average monthly temperatures at selected stations is shown in figure 2.2-2. The average temperature for the warmest month (July) is about 70° Fahrenheit, and for the coolest month (January) is about 32° Fahrenheit.

Daily precipitation and temperature data are available in monthly issues of "Climatological Data for New Mexico" and "Climatological Data for Arizona." The data are published by the U.S. Department of Commerce, National Oceanic and Atmospheric Administration.



Precipitation modified fro
Department of Agricultu

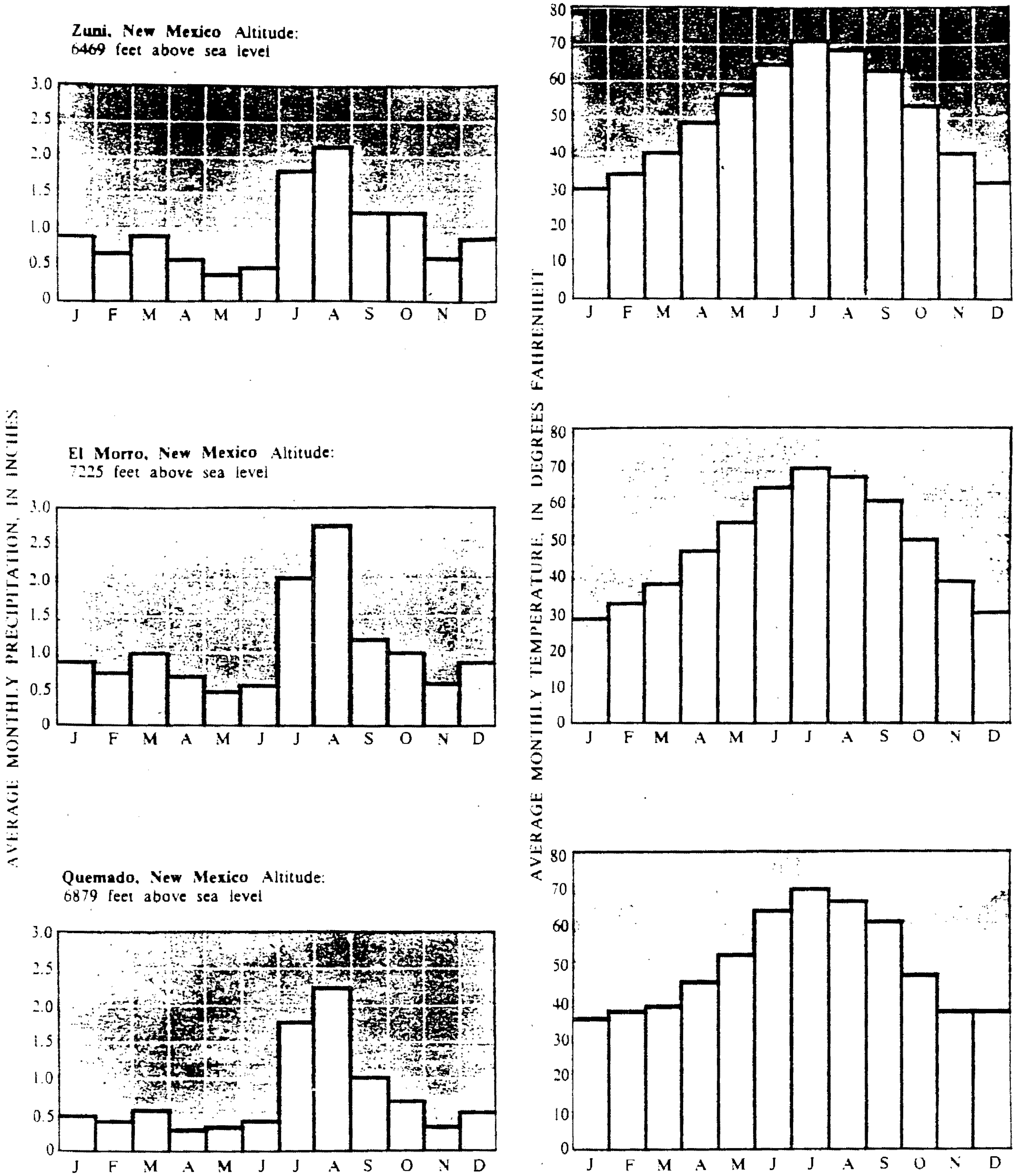
Base from U.S. Geological Survey
State base maps 1:500,000
Arizona 1981, New Mexico 1980

EXPLANATION

LINE OF EQUAL AVERAG
PRECIPITATION Interval, u

WEATHER STATION RECC
PRECIPITATION AND TEN

Figure 2.2-1 Average annual precipitation, 1931-60.



Climatological data compiled from U.S. Environmental Data Service, National Climatic Center (1980a, 1980b).

Figure 2.2-2 Average monthly precipitation and temperature at selected weather stations, 1941-70.

The Major Structural Features of the Coal Area were Largely Developed by Middle Tertiary Time

The major structural features in Area 62 are the southern San Juan Basin its bounding structures, and the Mogollon slope.

Area 62 lies in the southeastern quarter of the Colorado Plateau, one of the major structural provinces of the United States. The Plateau is characterized by a thick sequence of sedimentary rocks that indicate a long tectonic history (Foster, 1971, p. 363 and Kelley, 1951, p. 124-129). The southern part of the San Juan Basin, its major bounding structures (Kelley, 1951), and the Mogollon slope are the major structural features in Area 62 (fig. 2.5-1).

During the nineteenth century the study of sedimentary rocks and the plant and animal fossils they contained led to the development of the geological time scale (fig. 2.5-2). The scale shows the immensity of time involved for formation of the structural features in Area 62.

The San Juan Basin, a structural embayment of the Colorado Plateau, began to form during a period of uplift as early as Late Paleozoic time (Kelley, 1951, p. 130). The Defiance and Zuni uplifts the major highland elements in the southern San Juan Basin were forming in Paleozoic and Mesozoic Time. Kelley states that the present structural elements of the San Juan Basin were probably developed by Middle Tertiary time.

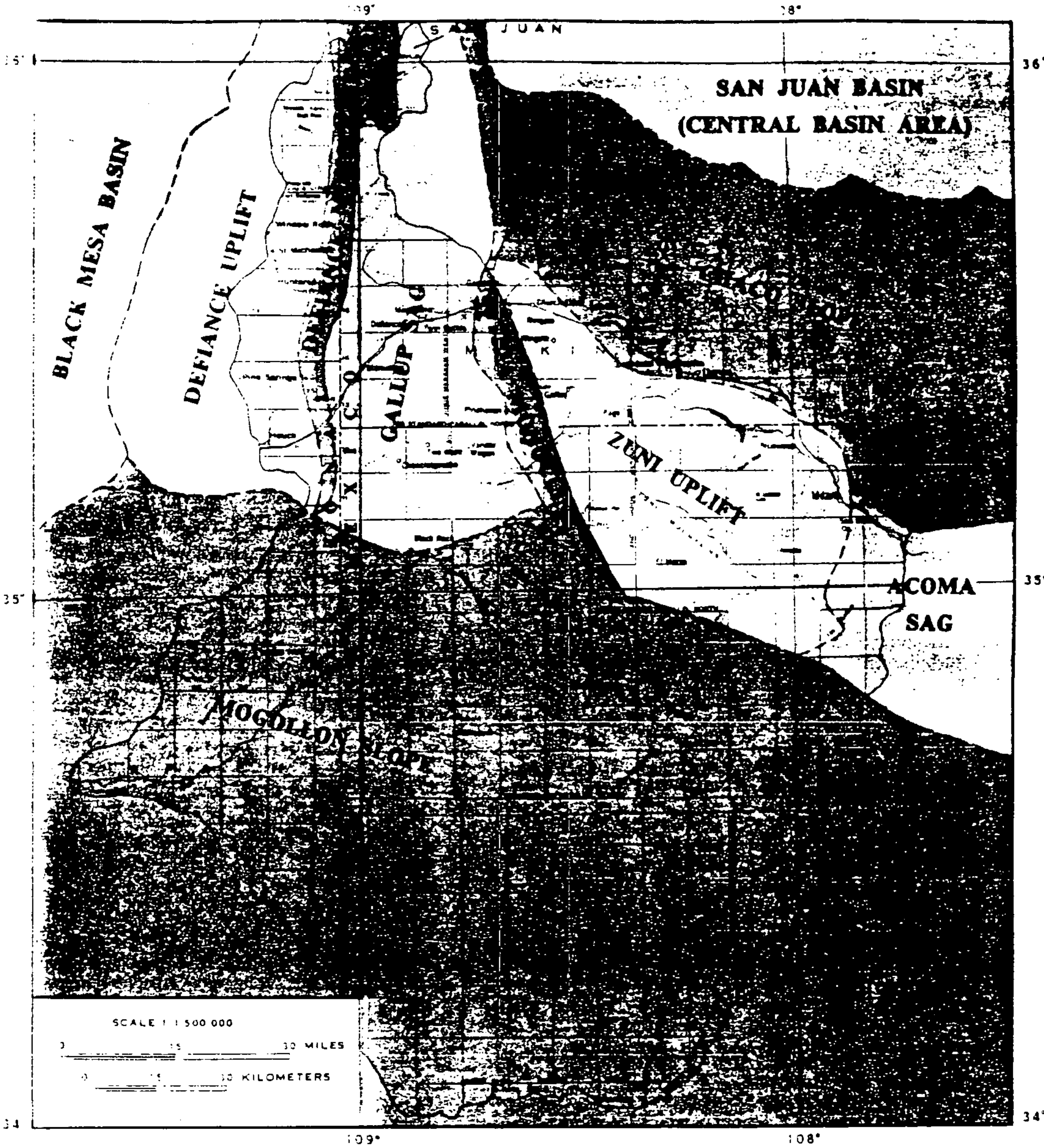
The Mogollon highland dominated the south side of the Colorado Plateau during Late Jurassic time. The south half of the highland (shown in fig. 2.5-1 as the Mogollon slope) was broken and tilted to the northeast during volcanic episodes at the end of the Jurassic Period (Saucier, 1976, p. 152). The Mogollon slope is the structural feature which represent the tectonic remnants of the Mogollon highland.

The Zuni and Defiance uplifts are located on the southern and western edges of the San Juan basin. The Zuni uplift trends northwestward, is 80 miles long by 35 miles wide, and has a structural relief of 5,500 feet (Kelley, 1951, p. 126). The steep limb of the uplift dips southwestward away from the basin. The Defiance uplift trends northward past the study area, is 100 miles long by 30 miles wide, and has a maximum structural relief of 7,500 feet (Kelley, 1967, p. 28). The steep limb dips east toward the San Juan basin (Kelley, 1951).

Two structural platforms (Kelley, 1951, p. 126) are located in the study area: The Acoma sag and the Gallup sag. The Acoma sag is a flat wide area bordering the Zuni uplift on the east. The Gallup sag extends from the San Juan basin southward between the Defiance and Zuni uplifts (Kelley, 1967, p. 29).

Two monoclines border the Gallup sag. The Nutria Monocline bounds the north two-thirds of the Zuni uplift on its west side (Kelley, 1967) and the Defiance monocline borders the Defiance uplift on its east side.

Kelley (1951, p. 126) describes the Chaco slope as the southern part of the San Juan Basin that lies between the Central Basin (fig. 2.5-1) and the Zuni uplift and Acoma sag. The Chaco slope resembles the platforms but differs from them because of "its more pronounced and continuous regional inclination toward the center of the basin and by the absence of a 'monocline' separating it from the Central Basin" (Kelley, 1951, p. 126).



Structural features modified from Kelley (1951, 1955)

EXPLANATION

UPLIFTS

BASINS AND PLATFORMS

SLOPES AND MONOCLINES

BOUNDARY BETWEEN STRUCTURAL FEATURES

Figure 2.5-1 Major structural features.

ERA	APPROXIMATE AGE IN MILLIONS OF YEARS*	PERIOD (System)	EPOCH	TECTONIC FEATURES (Approximate time of formation)
CENOZOIC	010	Quaternary	Holocene	
	2		Pleistocene	
	5	Tertiary	Pliocene	
	24		Miocene	
	38		Oligocene	OTHER UPLIFTS PLATFORMS MONOCLINES
	55		Eocene	MOGOLLON SLOPE
			Paleocene	ZUNI AND DEFIANCE UPLIFTS
	63			SAN JUAN BASIN
MESOZOIC	138	Cretaceous		COLORADO PLATEAU
	205	Jurassic		
		Triassic		
	← 240			
PALEOZOIC	290	Permian		
	← 330	Pennsylvanian		
	360	Mississippian		
	410	Devonian		
	435	Silurian		
	500	Ordovician		
		Cambrian		
	← 570			
PRECAMBRIAN				
	4550			

*Ages shown are estimates based on isotopic and biostratigraphic age assignments.
Age of rocks represented by ← are not supported as closely by existing data.

Figure 2.5-2 Geologic time.

Exposed Rocks Range in Age from Precambrian to Quaternary

Cretaceous rocks in the New Mexico part of the study area make up the most extensive outcrops of any of the rock units.

Exposed rocks in the area range in age from Precambrian (older than 570 million years ago) to Quaternary (about 10,000 years age to the present). The geologic map (fig. 2.6-1) shows the rocks exposed at the surface. Cross sections in section 4.5 provide information on stratigraphic relationships. Exposures of Precambrian gneissic granite are found southeast of Gallup in the Zuni Mountains (Hackman and Olson, 1977). Rocks of Cambrian through Mississippian age do not crop out in the study area. Pennsylvanian to Permian rocks of the Supai Formation are exposed along the Defiance uplift (fig. 2.5-1) in Apache County. The lithology of the Supai Formation consists of alternating beds of reddish-brown sandstone, siltstone, mudstone and white gypsum and gray limestone (Hackman and Olson, 1977).

A thick sequence of Permian rocks was deposited by alternating transgressions and regressions of the sea (McKee, 1967, p. 219). Extensive exposures of Permian rock are present along the Defiance uplift in Apache County, Arizona, and the Zuni uplift in Cibola and McKinley Counties, New Mexico. The Permian De Chelly Sandstone in Apache County is composed of orange, pink, and red fine-to-medium-grained sandstone (Hackman and Olson, 1977). The exposed Permian sequence of rocks in Cibola and McKinley Counties in ascending order consists of the Abo and Yeso Formations, the Glorieta Sandstone, and the San Andres Limestone. The Abo and Yeso Formations of Early Permian age are composed mostly of reddish sandstone and siltstone with several limestone and gypsum beds in the upper part of the Yeso Formation (Hackman and Olson, 1977). The Glorieta Sandstone, a white and buff-colored sandstone, is overlain by the San Andres Limestone, a gray and yellow thick-bedded dolomitic limestone (Hackman and Olson, 1977).

Triassic, Jurassic, and Cretaceous sediments were deposited in continental, near-shore, and marine environments. Frequent facies changes represent the fluctuations of the depositional environments and regional unconformities illustrate periods of erosion in Mesozoic time.

The Moenkopi Formation and Chinle Formation are the Triassic sedimentary rocks in Area 62. The Moenkopi Formation is composed mainly of red to brown gypsiferous sandstone, siltstone, and shale and is shown in figure 2.6-1 as part of the Triassic rocks cropping out in southern Apache County. The Chinle Formation, a variegated sequence of sandstone and siltstone (Repenning and others, 1969, p. B-2) is exposed near Window Rock, Arizona, along the Zuni River in Arizona, in southern and central McKinley and northern Cibola Counties, New Mexico (fig. 2.6-2).

Rocks in the Glen Canyon Group are probably both Jurassic and Triassic in age and are found in the northern part of the study area along the Arizona-New Mexico boundary, in southern and central McKinley County, and northern Cibola County. The Glen Canyon Group contains several formations that are composed mainly of sandstone and siltstone and that have cross-bedding (Cooley and others, 1969, p. A-14).

Middle and Upper Jurassic sedimentary rocks include the San Rafael Group, the Zuni Sandstone (fig. 2.6-2) and the Morrison Formation, which lie unconformably on the Glen Canyon Group. They are exposed in the northern part of the study area in Arizona, in southern and central McKinley County, and northern Cibola County. These formations consist of mostly sandstone with some silty sandstone and siltstone (Cooley and others, 1969, p. A-14 and Dane and Bachman, 1965).

Cretaceous rocks form the most extensive outcrops of rock units in the New Mexico part of the study area. The Dakota Sandstone and Mancos Shale exposures are scattered throughout the area. These formations are composed of mostly gray, yellow, and orange sandstone, shale, clay, and silt (Hackman and Olson, 1977). The Mesaverde Group overlies the Mancos Shale and major lithologies are characterized by transgressive and regressive wedges of sandstone with thick lenses of shale and coal (Silver, 1951, p. 111-113).

Tertiary formations include the Bidahochi and the Baca Formations which are mostly fluvial sediments and contain some sediments of volcanic origin (Orr, 1982, p. 30 and U.S. Department of Agriculture, 1981a, p. 1-14). These formations are present in the southern part of the study area. The Tertiary Chuska Sandstone contains wind-blown and fluvial sediments and is present along the extreme northern edge of the area (Cooley and others, 1969, p. A-17). Other sedimentary rocks are included in the Tertiary designation on figure 2.6-1 and consist of conglomerate, sandstone, siltstone, and limestone. They are found at the surface in the western and central parts of the study area.

A considerable amount of volcanic activity started in Tertiary time and continued through much of Quaternary time (Cooley and others, 1969, p. A-17). Outcrops of Tertiary and Quaternary lava flows and volcanic deposits (including volcanic breccia, tuff, basalt, and cinders) are present along the southeastern edge of the area at Pie Town, New Mexico, westward to the State line and into southern Apache County, Arizona, and in the northeast including the Mount Taylor volcanic field. Necks, volcanic buttes, and diatremes protrude locally and are composed mostly of intrusive igneous rocks (rhyolite, trachyte, and latite), basalt, and consolidated ash (tuff) (Callaghan, 1951, p. 120-122, and U.S. Department of Agriculture, 1981a, p. 1-14).

Quaternary and Tertiary alluvium and bolson deposits are found mostly along streams and valleys, and as landslide deposits throughout the study area. These sedimentary deposits are composed of sand, silt, and gravel.

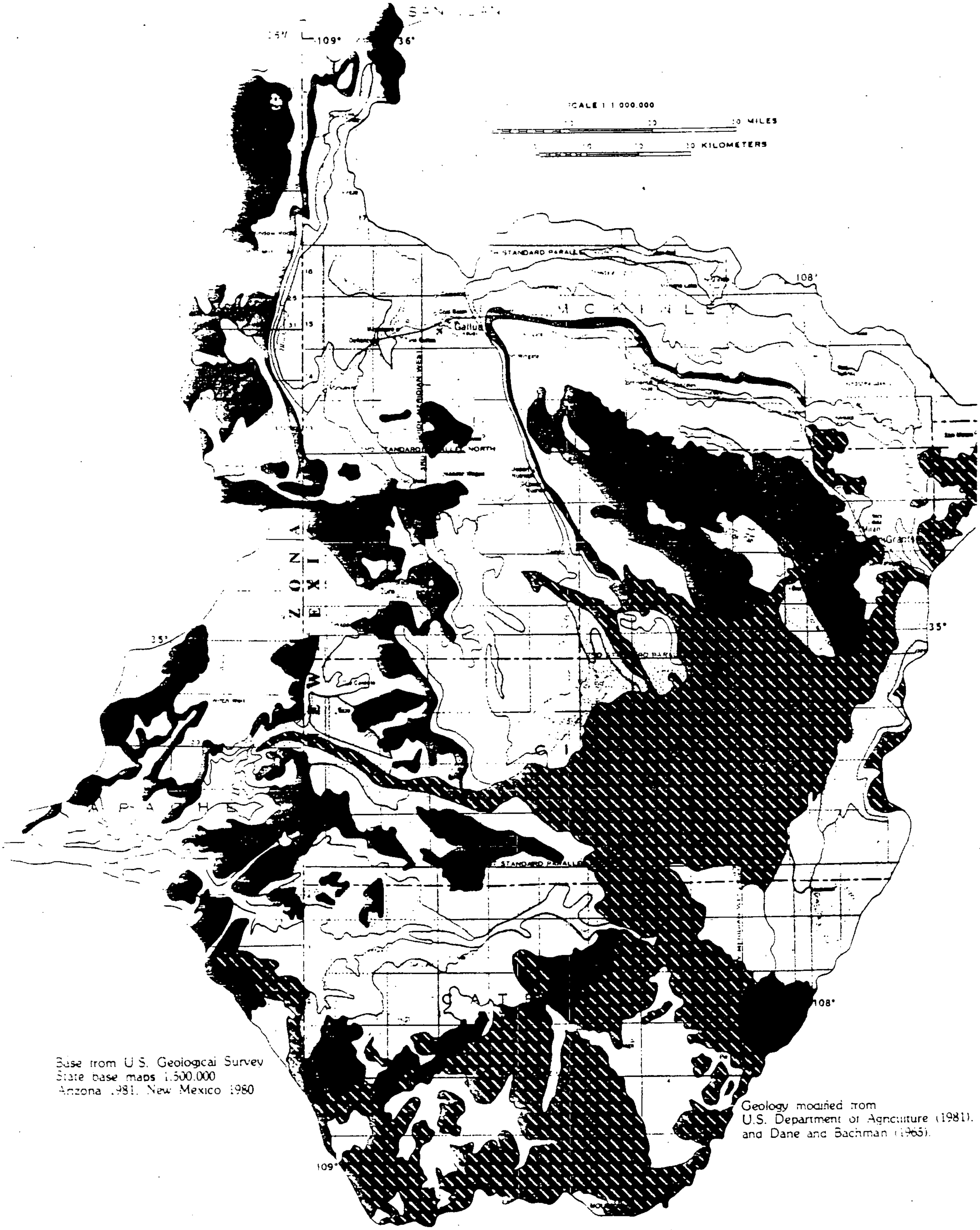


Figure 2.6-1 Generalized geologic map.

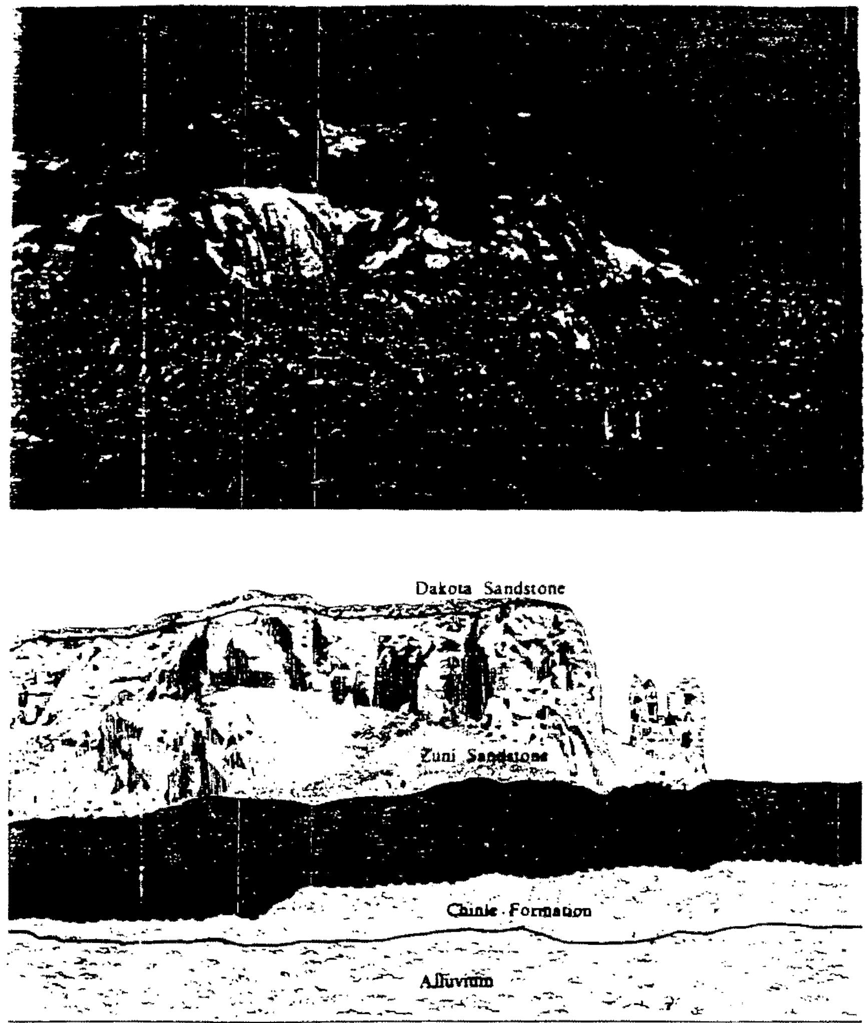


Figure 2.6-2 Dowa Yallane Mesa near Zuni, New Mexico, showing exposed formations (contact dashed where approximated).

EXPLANATION

UATERNARY AND ERTIARY	ALLUVIUM AND BOLSON DEPOSITS
	IGNEOUS ROCKS, INCLUDES BASALT FLOWS, VOLCANIC BRECCIA, TUFF AND INDERS, AND EXPOSED INTRUSIVE IGNEOUS ROCKS
ERTIARY	SEDIMENTARY ROCKS INCLUDING BIDAHOCHI FORMATION, CHUSKA SANDSTONE, AND BACA FORMATION
RETACEOUS	MESAVERDE GROUP
	MANCOS SHALE AND DAKOTA SANDSTONE UNDIVIDED
JURASSIC	MORRISON FORMATION, ZUNI SANDSTONE, AND SAN RAFAEL GROUP, UNDIVIDED
JURASSIC AND RIASSIC	GLEN CANYON GROUP
RIASSIC	CHINLE FORMATION; LOCALLY INCLUDES MOENKOPI FORMATION
PERMIAN	SAN ANDRES LIMESTONE AND GLORIETA SANDSTONE IN NEW MEXICO, DE CHELLY SANDSTONE IN ARIZONA, AND THE YESO AND ABO FORMATIONS IN NEW MEXICO
PERMIAN AND NNSYLVANIAN	SUPAI FORMATION
PRECAMBRIAN	PRECAMBRIAN ROCKS, UNDIVIDED

Streamflow-Gaging Network Consists of 25 Stations

Streamflow data have been collected for a variety of needs.

Data have been collected at three types of streamflow gaging stations in Area 62. These stations, classified as continuous, partial-record, and miscellaneous, have been established in response to various needs and provide differing types of streamflow information. For example, daily mean discharges, peak flows, base flows, and instantaneous measurements for the complete year are available for continuous-record stations. The daily mean discharges are computed from records of continuous stage readings collected at the stations. Data concerning peak flows, low-flows and some instantaneous measurements are available at partial-record stations. Instantaneous measurements of streamflow are made at miscellaneous stations. The gaging stations were established for various purposes, including long term hydrologic assessment, data collection for short-term projects established to study specific problems, or in response to data needs caused by legal decisions or compacts.

The Continental Divide, shown in figure 3.1-1, crosses the study area. Streams to the east of the Divide are within the Rio Grande basin. The Rio San Jose (fig. 3.1-2) is included in this area. Streams to the west of the Divide, which include the Zuni River, Black Creek, Puerco River, and Carrizo Wash-Largo Creek are part of the Little Colorado River basin. The major river basins in the study area are delineated in figure 3.1-1.

The locations of the stations for which streamflow data were analyzed in this report are shown in figure 3.1-1. Periods of record, drainage areas and other information about the streamflow stations are tabulated in section 6.1. As noted in section 6.1 some of the stations shown have been discontinued or changed from partial record to continuous record. Fifteen of the 25 stations are currently being operated. Miscellaneous discharge measurements have not been included in analysis of surface-water data performed in the following sections.

Data from miscellaneous stations are available from the Geological Survey offices in Tucson, Arizona and Albuquerque, New Mexico.

Additional details about the period of record and type of data collected as well as the actual data, are available from computer storage through the National Water Data Exchange (NAWDEX) (section 5.2) and WATSTORE (section 5.3).

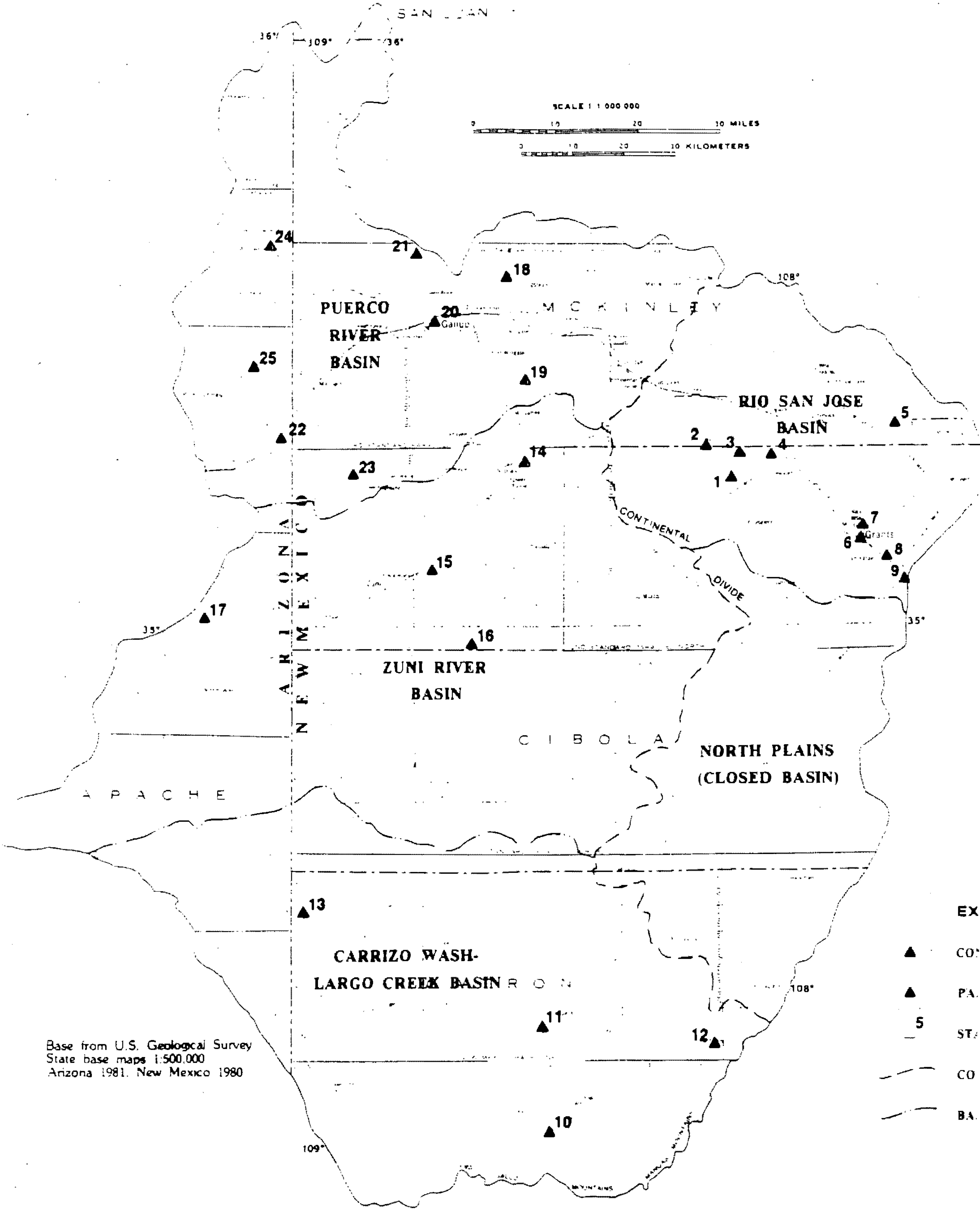


Figure 3.1-1 Location of surface-water gaging stations.

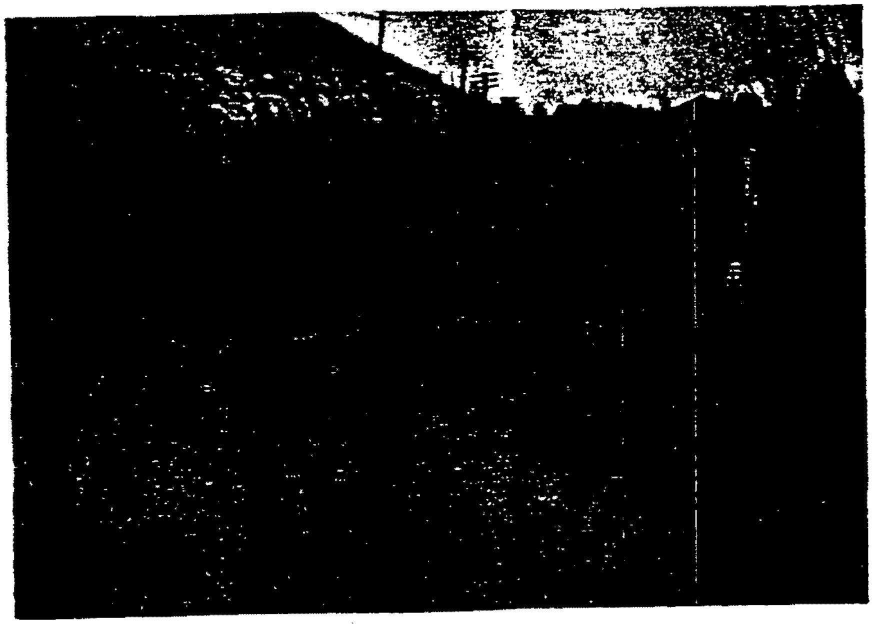


Figure 3.1-2 Streamflow-gaging station (9), Rio San Jose near Grants, New Mexico.

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OUS-RECORD GAGING STATION

CORD GAGING STATION

AND NUMBER

AL DIVIDE

IDE

Streamflows Exhibit Marked Changes Throughout the Year

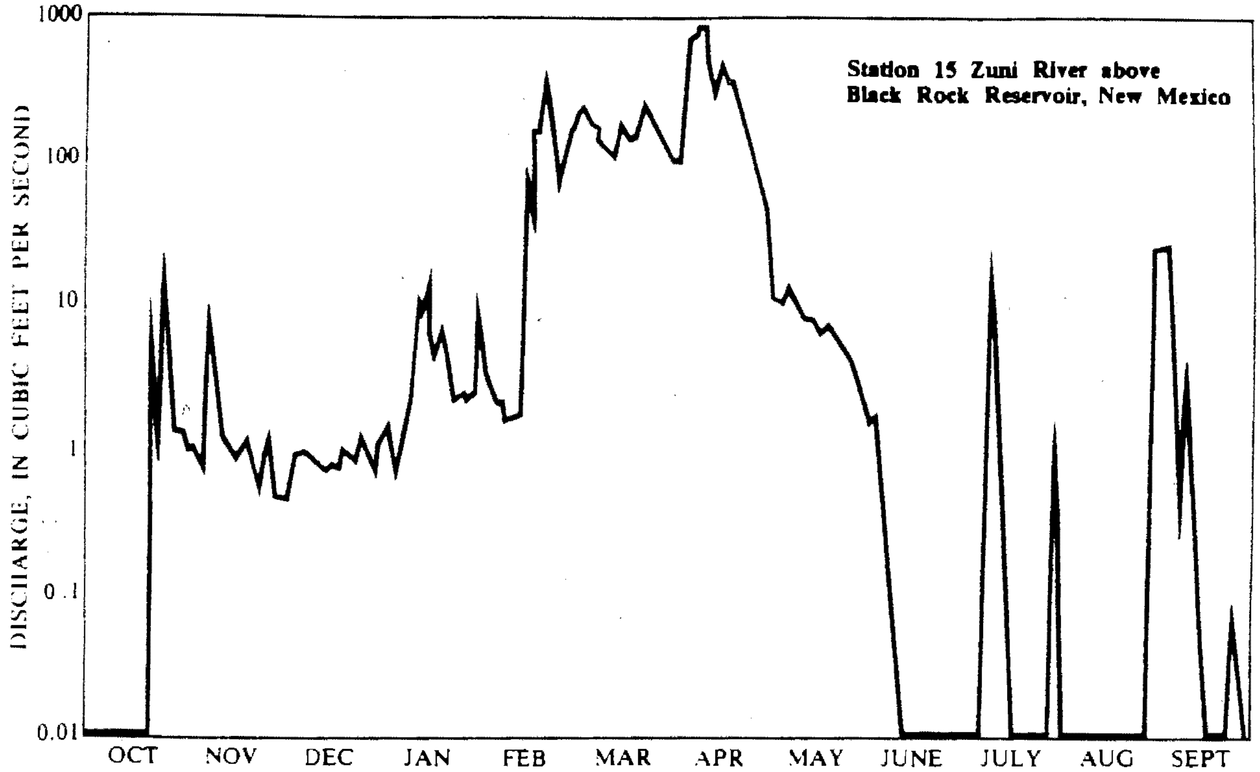
Variation in streamflow is directly related to rainfall and snowmelt.

Most streams draining Area 62 are typical of streams in arid or semiarid lands. For such streams, there is no flow during most of the year. Most of the streamflow results from infrequent intense storms and from snowmelt causing a great deal of variability within a year.

To illustrate the variability of streamflow that exists within a particular year, streamflow hydrographs for the 1980 water year for the Zuni River (subject to regulation from upstream reservoirs) and Rio San Jose (regulated by Bluewater Lake) are presented in figure 3.2-1. As can be seen, there is little flow for much of the year. The periods of no flow can be contrasted against the peaks resulting from surface runoff from snowmelt and storms. Storm activity results in "flashy" peaks; that is, the storms result in a rapid rise in streamflow to the peak, followed by a rapid decrease in flow.

The monthly mean, maximum, and minimum for flows on the Rio San Jose and Zuni River for the period of record are summarized in figure 3.2-2. A majority of the annual discharge occurs from March through August in response to snowmelt and storms. Differences between the maximum and minimum flows are variable from month to month. Maximum discharges vary greatly between months, while the minimum discharges are zero for most months. For contrast, the maximum and minimum flows are summarized below for the Zuni River and Rio San Jose.

Map No.	Station Name	Maximum average flow		Minimum average flow		Average flow
		Flow	Water year	Flow	Water year	
15	Zuni River above Black Rock Reservoir, N. Mex.	46.9	1973	1.39	1972	13.0
6	Rio San Jose at Grants, N. Mex.	28.7	1916	0.01	1961	3.22



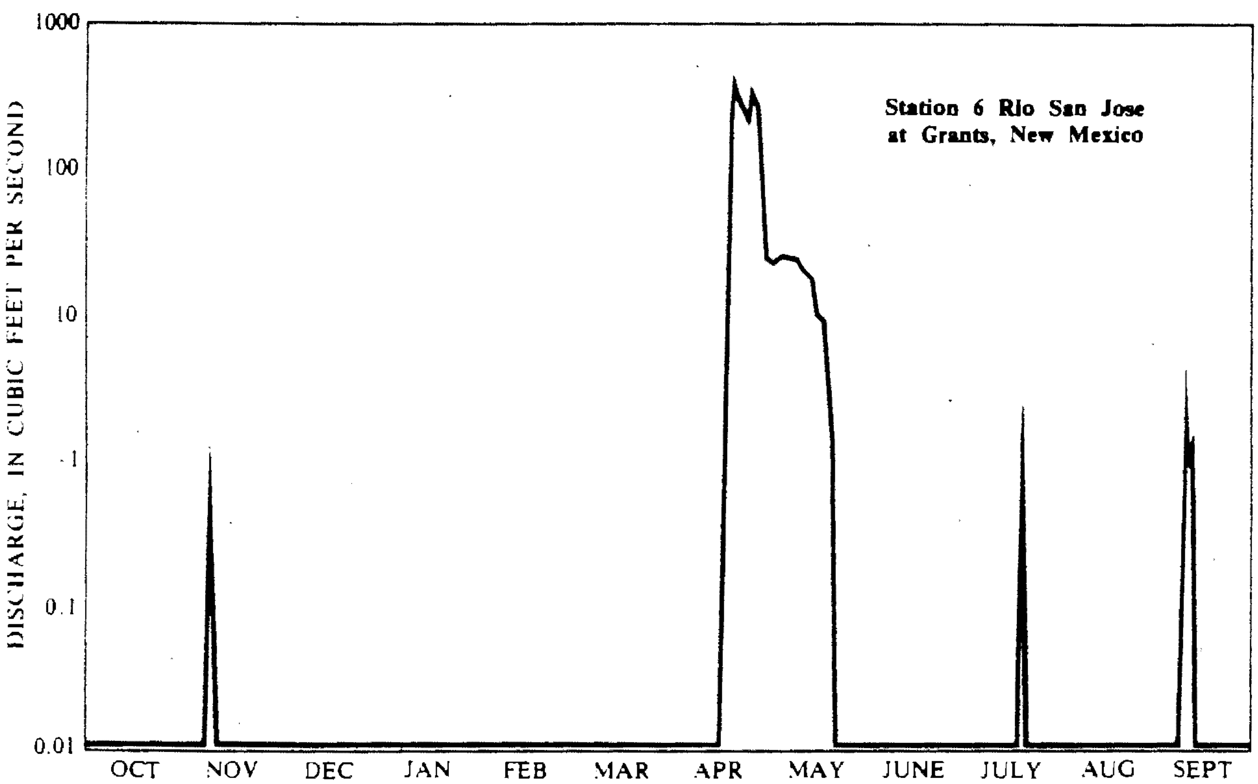


Figure 3.2-1 Daily mean discharge hydrographs (1980 water year) for Zuni River and Rio San Jose.

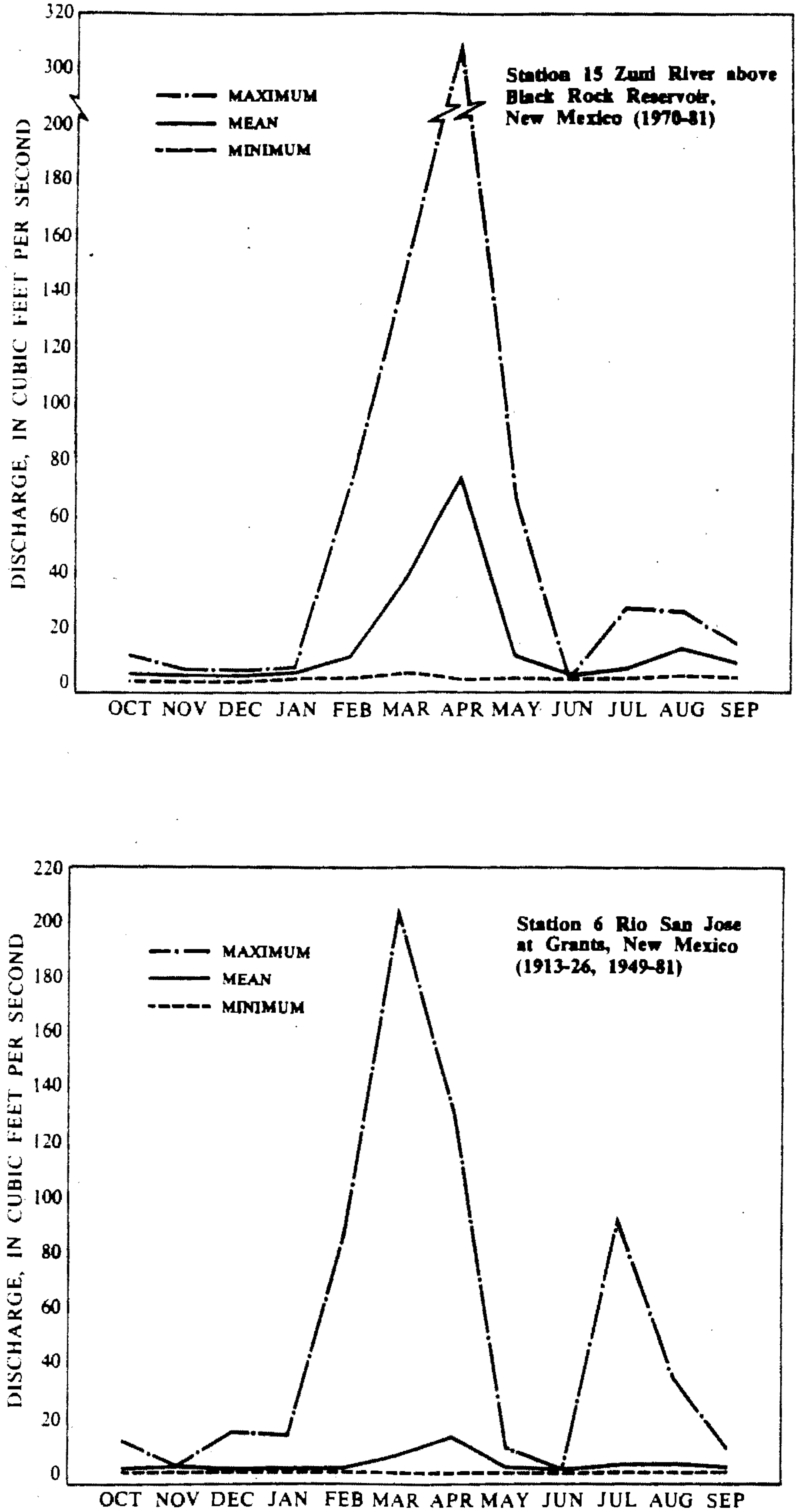


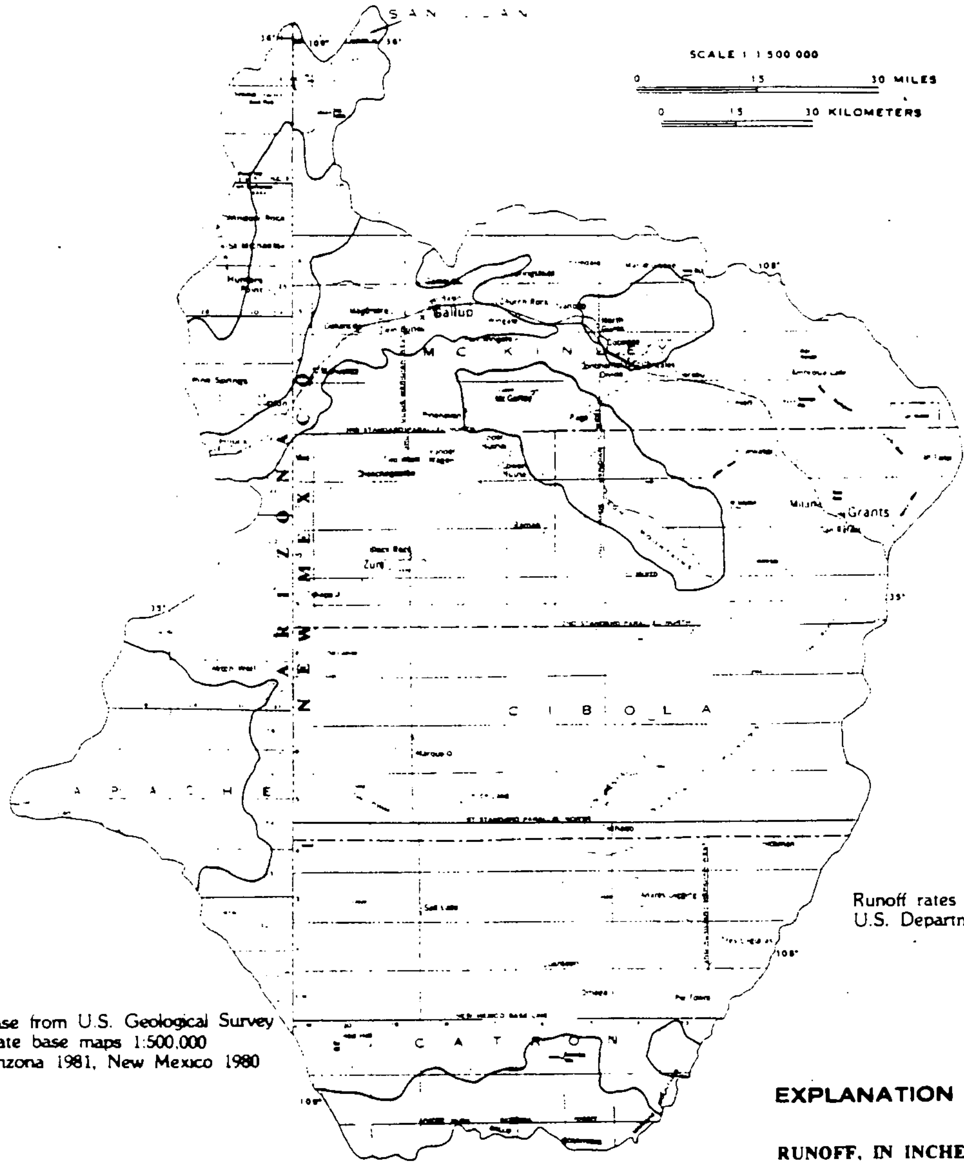
Figure 3.2-2 Maximum, mean, and minimum monthly mean discharges for the Zuni River and Rio San Jose.

Mean Annual Runoff is 1.0 Inch or Less

Mountainous areas contribute the most runoff; base flows are indicative of no ground-water contribution.

A map delineating the distribution of mean annual unit runoff (mean annual runoff divided by drainage area) in Area 62 is shown in figure 3.3-1. The map, modified from one published by the U.S. Department of Agriculture (1981b), represents runoff in terms of average depth of yearly runoff in inches. Mountainous areas contribute the highest runoff value of 1.0 inch with the lower altitudes contributing less runoff. As pointed out in the U.S. Department of Agriculture publication, for streams draining the mountainous areas, unit runoff decreases downstream.

Base flow is defined as streamflow that is composed only of ground-water discharge. Most unregulated streams in Area 62 are ephemeral, flowing only in response to storms and snowmelt. Base flow for these streams is zero indicating no significant ground-water discharge. Streams that continue to flow when the ephemeral streams have gone dry, do so as a result of spring discharge or man-made discharges, such as from treatment plants or reservoirs. For example, the Rio San Jose near Grants continues to flow due to discharges from Horace Springs and the Grants sewage treatment plant.



Runoff rates modified from
U.S. Department of Agriculture (1981b)

Base from U.S. Geological Survey
State base maps 1:500,000
Arizona 1981, New Mexico 1980

EXPLANATION

RUNOFF, IN INCHES

Less than 0.1

0.1-0.5

0.5-1.0

Figure 3.3-1 Mean annual unit runoff.

Flood Magnitude and Frequency Values Computed for Selected Streams

Technique available to estimate peak flood flows for ungaged streams.

Flood magnitude and frequency data for gaged streams having more than 10 years of peak-discharge record are listed in table 3.4-1. The flood values were computed using the station record according to guidelines outlined by the U.S. Water Resources Council (1981).

A multiple regression model was used by Thomas and Gold (1982) to develop flood-estimating equations for ungaged streams in New Mexico. The equations were developed using data from stations throughout New Mexico, as well as in Arizona bordering New Mexico; thus, the equations are applicable to all parts of Area 62. Basin characteristics, such as station altitude, rainfall, and drainage area were used as the independent variables, with flood flows at each gaged station used as the dependent variables. A complete description of the development of the equations can be found in Thomas and Gold (1982). The equations for estimating peak flood magnitudes for return intervals of 10 years (Q_{10}), 50 years (Q_{50}), and 100 years (Q_{100}) are presented below.

Estimating equation	Interval covered by standard error of estimate (percent)
$Q_{10} = 3.88 \times 10^{[illegible]} A^{[illegible]} (Sa/1,000)^{[illegible]}$	+124 -55
$Q_{50} = 2.01 \times 10^{5} A^{0.403} (Sa/1,000)^{-3.18}$	+140 -58
$Q_{100} = 3.54 \times 10^{5} A^{0.389} (Sa/1,000)^{-3.32}$	+145 -59

In the equations, A is the contributing drainage area in square miles and Sa is site altitude in feet above sea level. For example, the 100-year recurrence flood at a site having an altitude of 6,300 feet and a drainage area of 6.76 square miles would be estimated by the following calculations: (3.54×10^5) $(6.76)^{0.389}$ $(6,300/1,000)^{-3.32}$ = 1,700 cubic feet per second. This value is subject to the large interval of standard error listed with the estimating equations.

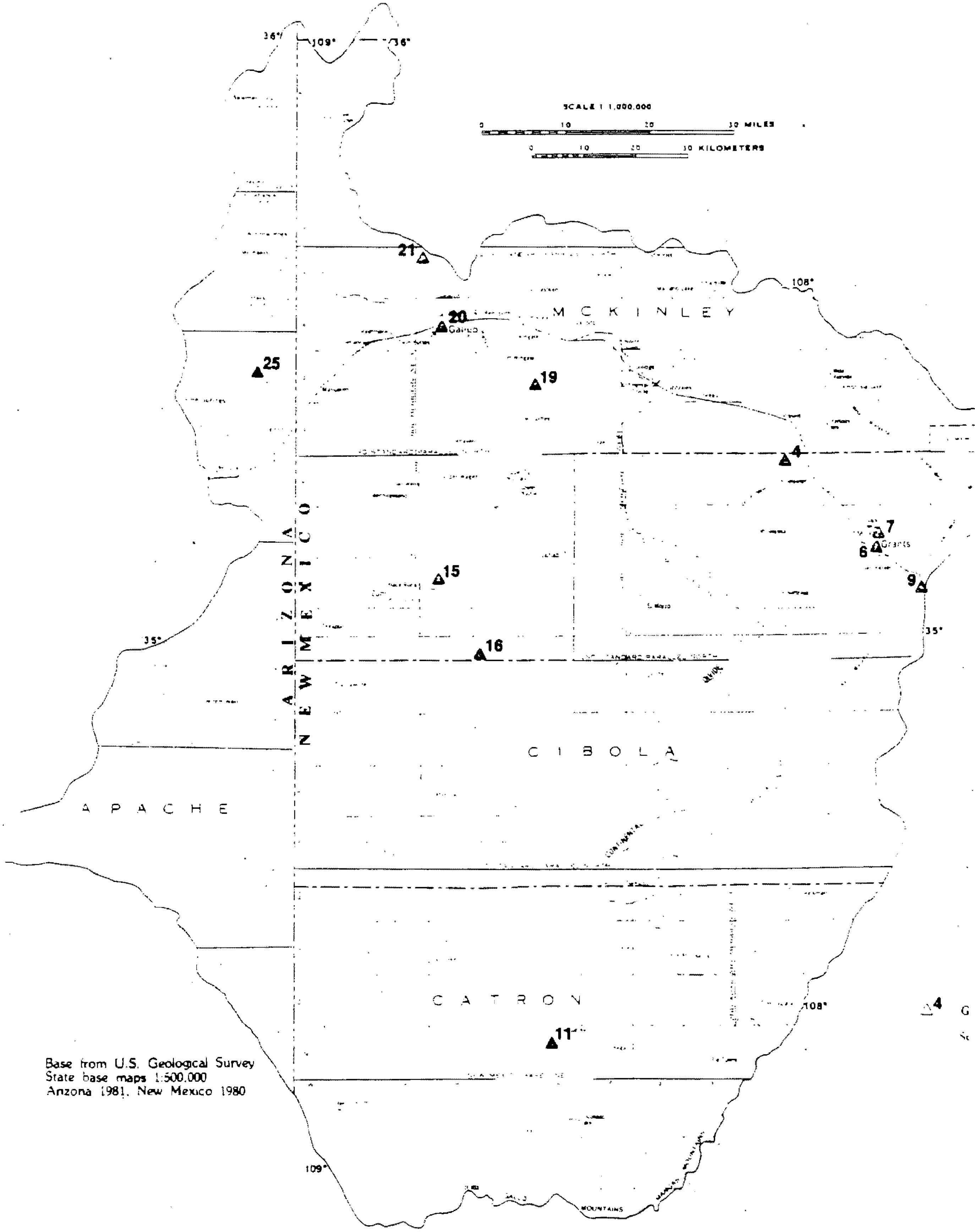


Figure 3.4-1 Locations of stations where flood magnitude and frequency have been computed.

Table 3.4-1 Flood magnitude and frequency at selected stations.

Station number	Station name	Discharge, in cubic feet per second, for the indicated recurrence interval in years		
		10	50	100
4[1]	Bluewater Creek near Bluewater, N. Mex.	3,640	8,430	11,300
6[2]	Rio San Jose at Grants, N. Mex.	662	1,800	2,900
7	Grants Canyon at Grants, N. Mex.	1,040	2,200	[illegible]
9[2]	Rio San Jose near Grants, N. Mex.	766	1,440	[illegible]
11	Largo Creek near Quemado, N. Mex.	788	1,400	[illegible]
15[3]	Zuni River above Black Rock Reservoir, N. Mex.	3,930	7,540	[illegible]
16	Galestena Canyon Tributary near Black Rock, N. Mex.	435	835	[illegible]
19	Milk Ranch Canyon near Fort Wingate, N. Mex.	336	938	[illegible]
20	Puerco River at Gallup, N. Mex.	7,630	12,900	[illegible]
21	Wagon Trail Wash near Gomerco, N. Mex.	287	670	[illegible]
25	Black Creek near Lupton, Ariz.	5,370	8,060	[illegible]

[1] Flow regulated by Bluewater Dam
[2] Some withdrawals, diversions, and regulation upstream from station
[3] Some regulation from upstream reservoirs

PLANATION

TION AND NUMBER

... for detailed site description

Streamflow is Poorly Sustained

Duration curves indicate little, if any, contribution from ground-water sources.

The flow duration curve is a cumulative frequency curve of daily discharges showing the percent of time that specified discharges were equaled or exceeded during a given period.

The data presented in the duration curves (fig. 3.5-1) for 6 stations in Area 62 were computed using a Geological Survey computer program (Hutchison, 1975). The curves may be interpreted using the following guidelines. A steep slope indicates poorly sustained flow. For example, a steep slope at the lower end indicates that streamflow is not sustained by ground-water discharge and tends rapidly toward zero during periods of low precipitation. Gentler slopes indicate a more sustained streamflow such as would occur if ground-water or other stored water were discharged to the stream.

The duration curves for several representative stations presented in figure 3.5-1, have, with one exception, steep slopes throughout the lengths of those curves. The only exception, Rio Nutria, displays a moderate slope, and therefore a well sustained condition for flows less than 0.1 cubic foot per second. Streamflows recorded at the stations on the Rio San Jose, San Mateo Creek, Puerco River, and the Zuni River are subject to regulation which will cause the shape of their duration curves to differ from curves representing natural flow. Duration of flow figures for other streamflow stations are contained in table 3.5-1. The tabulated data can be used to draw duration curves for those stations.

Table 3.5-1 Flow-duration data at selected stations.

Station number	Station name	Flow, in cubic feet per second, which was equaled or exceeded for percentage of time indicated								
		99.5	95	90	75	50	25	10	5	1
3[1]	Bluewater Creek below Bluewater Dam, N. Mex.	0.21	0.27	0.29	0.38	0.42	3.8	20	25	31
4[1]	Bluewater Creek near Bluewater, N. Mex.	0.38	0.62	0.76	1.1	1.2	3.2	18.6	24	33
9[2]	Rio San Jose near Grants, N. Mex.	3.5	4.2	4.4	4.7	5.3	6.0	7.6	9.3	32
10	Largo Creek near Mangas, N. Mex.	0.04	0.09	0.09	0.1	0.21	0.38	0.62	1.5	20
25	Black Creek near Lupton, Ariz.	0.0	0.0	0.03	0.07	0.19	1.9	10.7	31	130

[1] Flow regulated by Bluewater Dam
[2] Affected by diversions and discharges from city of Grants

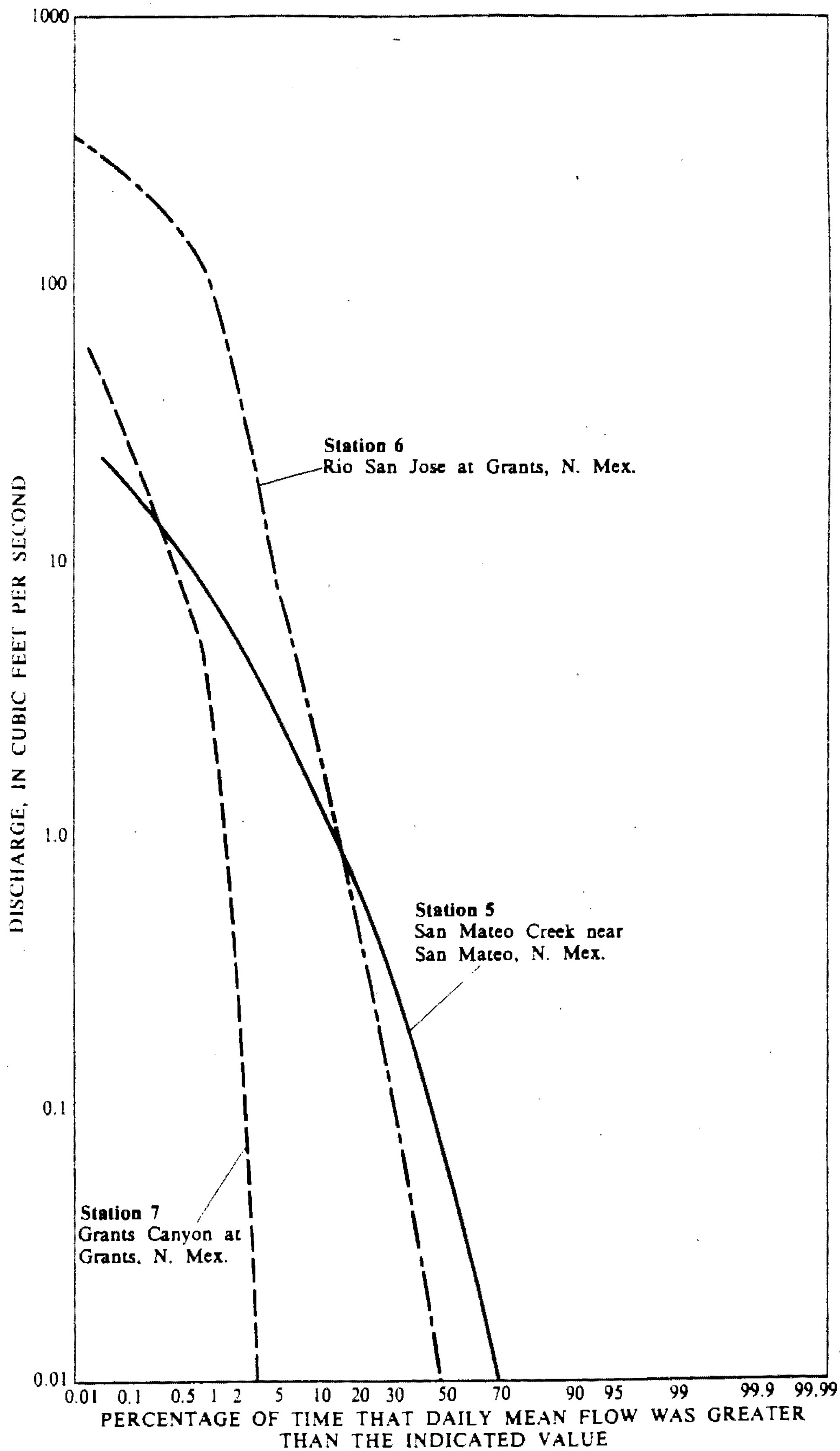
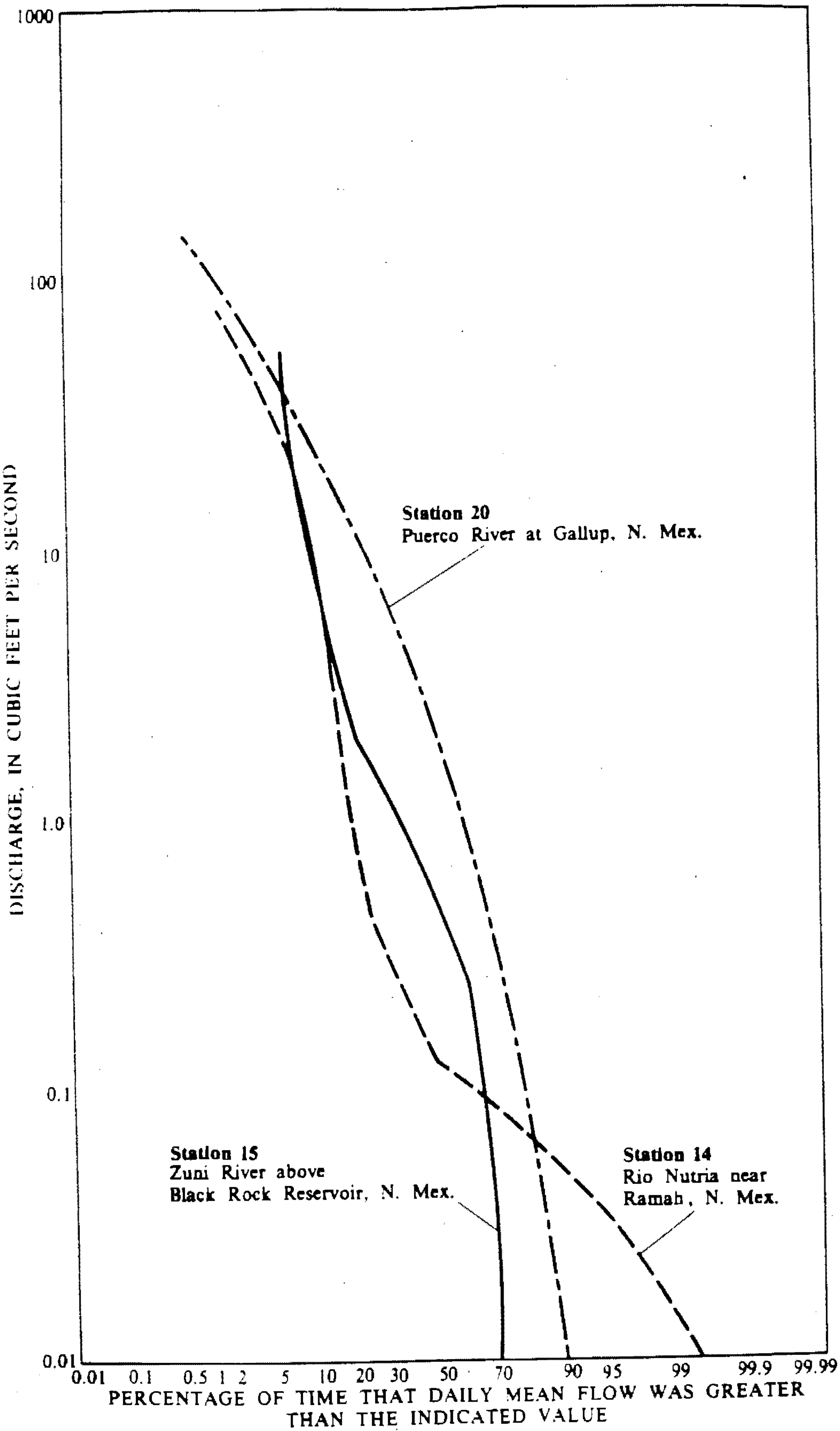


Figure 3.5-1 Flo\



...ation curves for selected stations.

Annual Erosion Rates Generally Less Than 1 Acre-Foot per Square Mile

Sediment yield is dependent on topographic setting, soil type, climatic factors, and land uses.

Erosion potential and the resulting sediment yield are of great interest in Area 62. The effects of erosion may include degradation of water quality, deposition of sediments in streambeds and reservoirs, decreased reservoir capacity, and removal of soils and nutrients. All aspects of erosion may result in an economic loss to the inhabitants of the area who use streams as water supplies, use the land for stock grazing or farming, or build structures. Area 62 is marked by areas where extreme erosion has occurred in the past and is continuing. The effects of erosion (fig. 3.7-2) can be observed in the alluvial valleys of the Puerco and Zuni Rivers and in numerous washes throughout the area.

The extent of erosion of the land by wind and water varies greatly within the area, mostly in response to a combination of factors. Specifically, surface geology, soil types, climate, runoff, topography, vegetative cover, land use, and upland drainage pattern all affect erosion rates. Erosion rates can be increased by some uses of the land, such as unimproved roads, construction sites, and by livestock grazing. High rates are also a result of geologic conditions within the area. Specifically, badland areas, sites of substantial erosion, are a result of the significant erosion potential of the relatively unconsolidated shales, mudstones, and claystones cropping out in those areas. Low erosion rates occur in areas having good grass cover and in forested areas.

Estimated erosion rates for Area 62 are shown in figure 3.7-1. Summaries of suspended-sediment data collected at gaging stations are given in table 3.7-1. The location of the gaging stations is shown in figure 3.7-1.

The suspended particles may contain certain chemical constituents in quantities greater than that found in the water surrounding those particles. The samples for the two Rio San Jose stations were collected when large quantities of water were released to relieve pressure on an upstream dam. The samples for the stations Puerco River near Church Rock (18) and Puerco River at Gallup (20), resulting in the maximum values, were collected after a dam failure at an upstream uranium-milling operation.

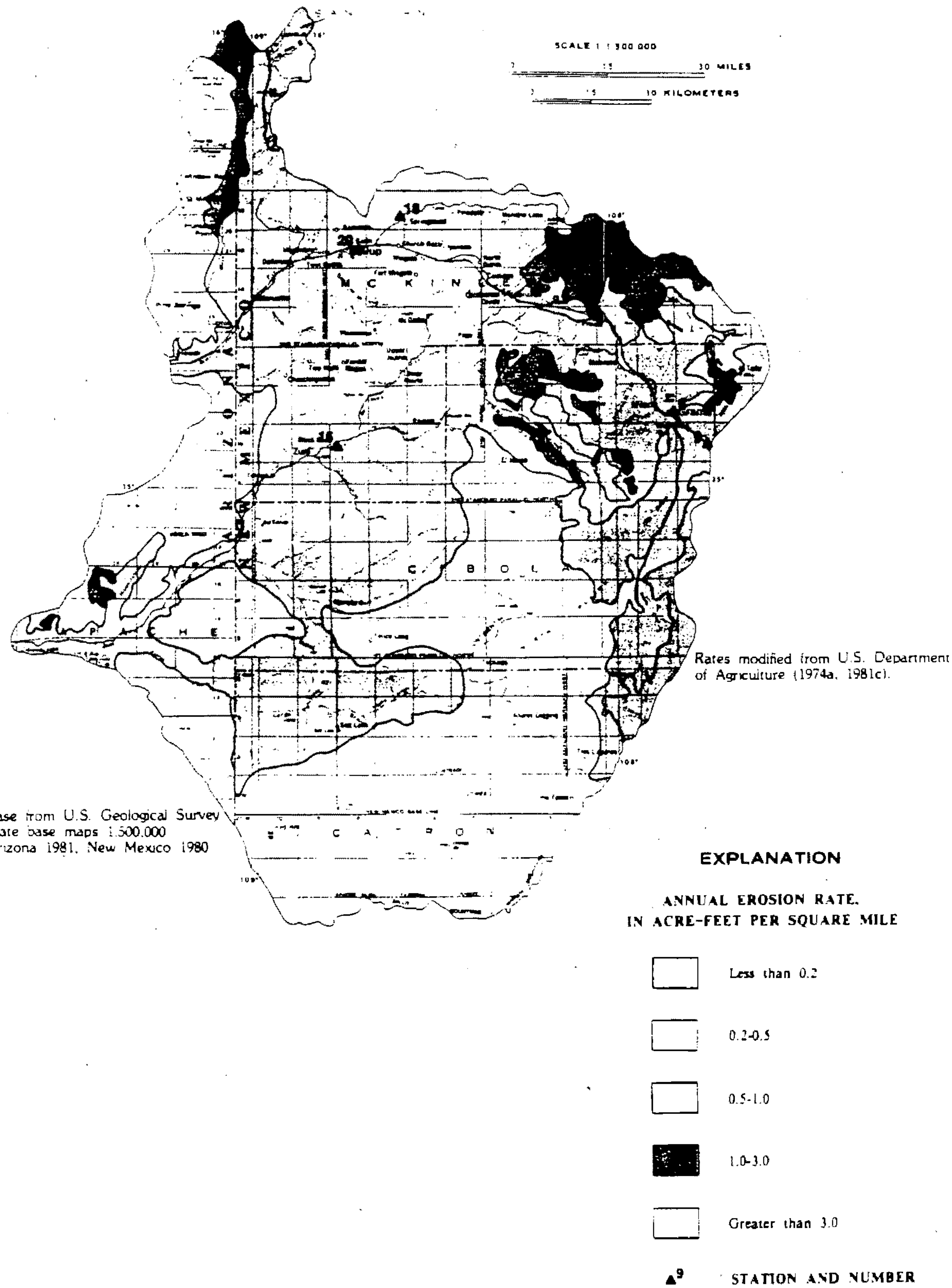


Figure 3.7-1 Soil erosion rates.

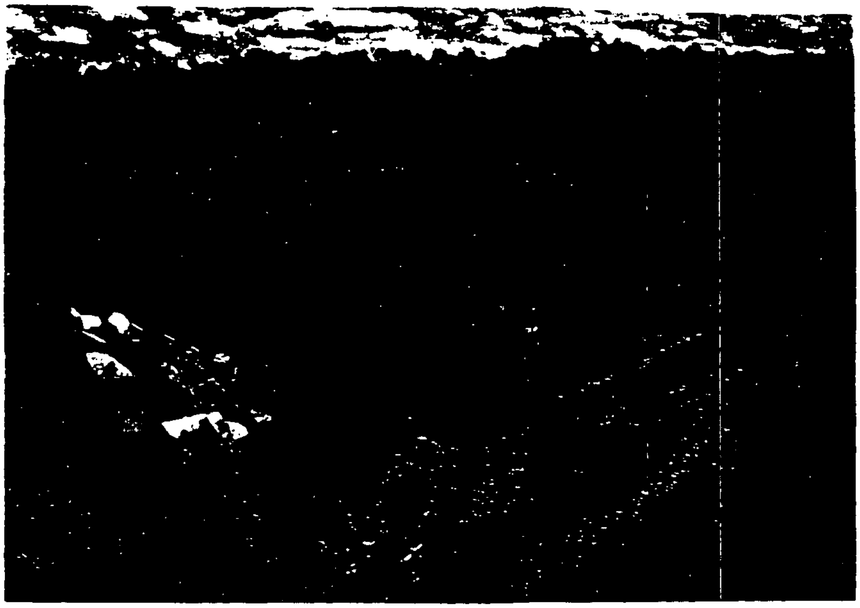


Figure 3.7-2 Effects of erosion in the alluvial valley (east of Gallup, New Mexico).

Table 3.7-1 Suspended sediment at gaging stations.

Station number	Station name	Number of samples taken	Suspended sediment concentration (mg/L) Mean	Minimum	Maximum
6	Rio San Jose at Grants, N. Mex.	4	3,540	523	8,300
9	Rio San Jose near Grants, N. Mex.	4	315	19.0	672
15	Zuni River above Black Rock Res., N. Mex.	35	345	18.0	2,090
18	Puerco River near Church Rock, N. Mex.	2		17,100	18,000
20	Puerco River at Gallup, N. Mex.	6	24,440	3,360	70,100

Ground-Water Recharge Occurs Primarily Above 6,000 Feet and Where Geology and Topography are Conducive to Infiltration

Major spring discharge occurs in the northwest and central parts of the study area.

Recharge to ground-water aquifers occurs primarily from infiltration of runoff from precipitation in the mountainous areas and on the flanks of structural basins (U.S. Department of Agriculture, 1981a, p. 5-22) (fig. 4.2-1). These highland areas, which account for as much as 80 percent of the ground-water recharge, are generally at an altitude greater than 6,000 feet above sea level and receive more than 15 inches of precipitation annually (Lower Colorado Region State-Federal Interagency Group for the Pacific Southwest Interagency Committee, 1971, p. V-21). Recharge probably occurs also on Mt. Taylor, along the Continental Divide, and in the Gallo and Mangas Mountains although it has not been mapped in these areas. Minor recharge also occurs from infiltration of excess irrigation water and canal seepage from surface-water sources and from infiltration of precipitation in the center of the basins. Infiltration in the center of the basin is generally negligible as a result of the arid to semiarid climate but may be affected by both topography and geology.

Ground water is discharged by four natural processes: (1) Evaporation in areas where the water table is near to the land surface; (2) transpiration by vegetation; (3) seepage into stream channels in places where the streambed (or channel) intersects the water table; and, (4) spring discharge (Lower Colorado Region State-Federal Interagency Group for the Pacific Southwest Interagency Committee, 1971, p. V-22).

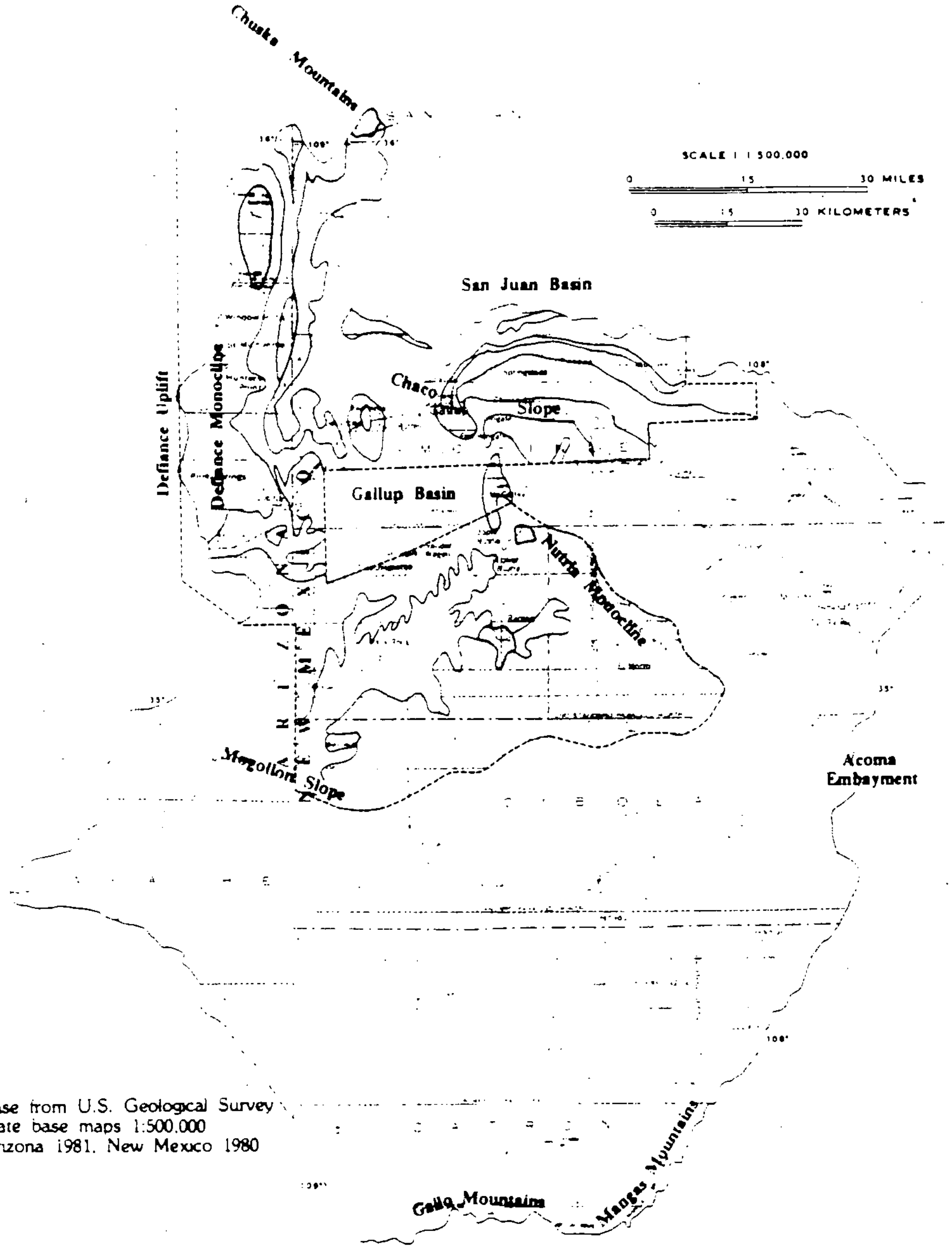
Only small amounts of ground water are discharged by evaporation in areas where the water table is near the surface (as the depth to the water table reaches 10 feet, discharge by evaporation becomes negligible). Large amounts of ground water are transpired from ground-water aquifers by vegetation.

Spring discharge occurs where the water table intersects the land surface or where water from artesian aquifers flows through fractures or fault zones in the rock (Lower Colorado Region State-Federal Interagency Group for the Pacific Southwest Interagency Committee, 1971, p. V-22). Major areas for spring discharge are in the vicinity of Ojo Caliente and Ramah. The combined discharge for springs near Ojo Caliente is about 1 cubic foot per second and for springs near Ramah combined discharge is about 1.1 cubic feet per second (Orr, 1982, p. 46, 90). Studies by Risser (1982) describe a spring called Ojo del Gallo located southwest of Grants, New Mexico. Ojo del Gallo yielded as much as 5 to 7 cubic feet per second in the 1930's, ceased flowing in the 1950's (Risser, 1982, p. 29), but has begun to flow again (J.A. Baldwin, oral communication, 1983). Springs on the southwest side of the San Juan Basin, around Window Rock, and in the Chuska Mountains usually do not yield any more than .02 cubic foot per second (Cooley and others, 1969, p. A-44). Other springs discharge near Black Rock Village, along outcrops of the Glorieta Sandstone and San Andres Limestone in the Zuni Mountains (Orr, 1982), and along the Zuni River in McKinley and Cibola Counties (Summers, 1972, p. 83).

Induced ground-water discharge takes place as ground-water pumpage from wells. Pumpage removes water from the flow system and thus diverts ground water from some of its natural points of discharge. This type of discharge will be discussed in more detail in Section 4.4.

The areas of ground-water recharge which have been mapped, and locally, areas of spring discharge are shown in figure 4.2-1. Several publications discuss ground-water recharge and discharge in specific aquifers but do not include maps. These publications include studies about the San Juan Basin (Lyford, 1979), Apache County (Akers, 1964), the Rio San Jose (Risser, 1982),and McKinley and Cibola Counties (Orr, 1982). Other information from some of these references describes gaining and losing reaches along some of the intermittent streams. In general ground water may be discharged to the stream (the stream gains) or the stream water may be recharged to the adjacent aquifer (the stream loses).

Ground-water movement in Area 62 is generally from recharge areas in the highlands to the central parts of the basins. Movement of ground water in central Apache County, Arizona, mainly is southward toward the Little Colorado River (Lower Colorado Region State-Federal Interagency Group for the Pacific Southwest Interagency Committee, 1970, p. V-21). Ground-water movement in New Mexico is toward the Puerco River in aquifers near Gallup (Lyford, 1979) and near Zuni; in Cibola County ground-water movement in the Glorieta-San Andres aquifer, the Chinle Formation, the Zuni-Dakota aquifer, and Bidahochi Formation is generally to the west (Orr, 1982). Locally, along the Nutria monocline, ground water in the Gallup Sandstone and Crevasse Canyon Formation moves toward the Rio Nutria and Rio Pescado, but ground water in more deeply buried Gallup and Crevasse Canyon rocks probably moves northward to join the flow system near Gallup (Orr, 1982, p. 77, 114).



EXPLANATION

RECHARGE AREA. *Modified from area mapped by Cooley and others (1969).*

RECHARGE AREA. *Modified from area mapped by Summers (1972).*

AREA OF PROBABLE GROUND-WATER DISCHARGE FROM SPRINGS

AREA MAPPED FOR GROUND WATER RECHARGE
Note: Recharge areas in other parts of Area 62 have not been mapped.

Figure 4.2-1 Location of recharge areas and spring discharge areas.

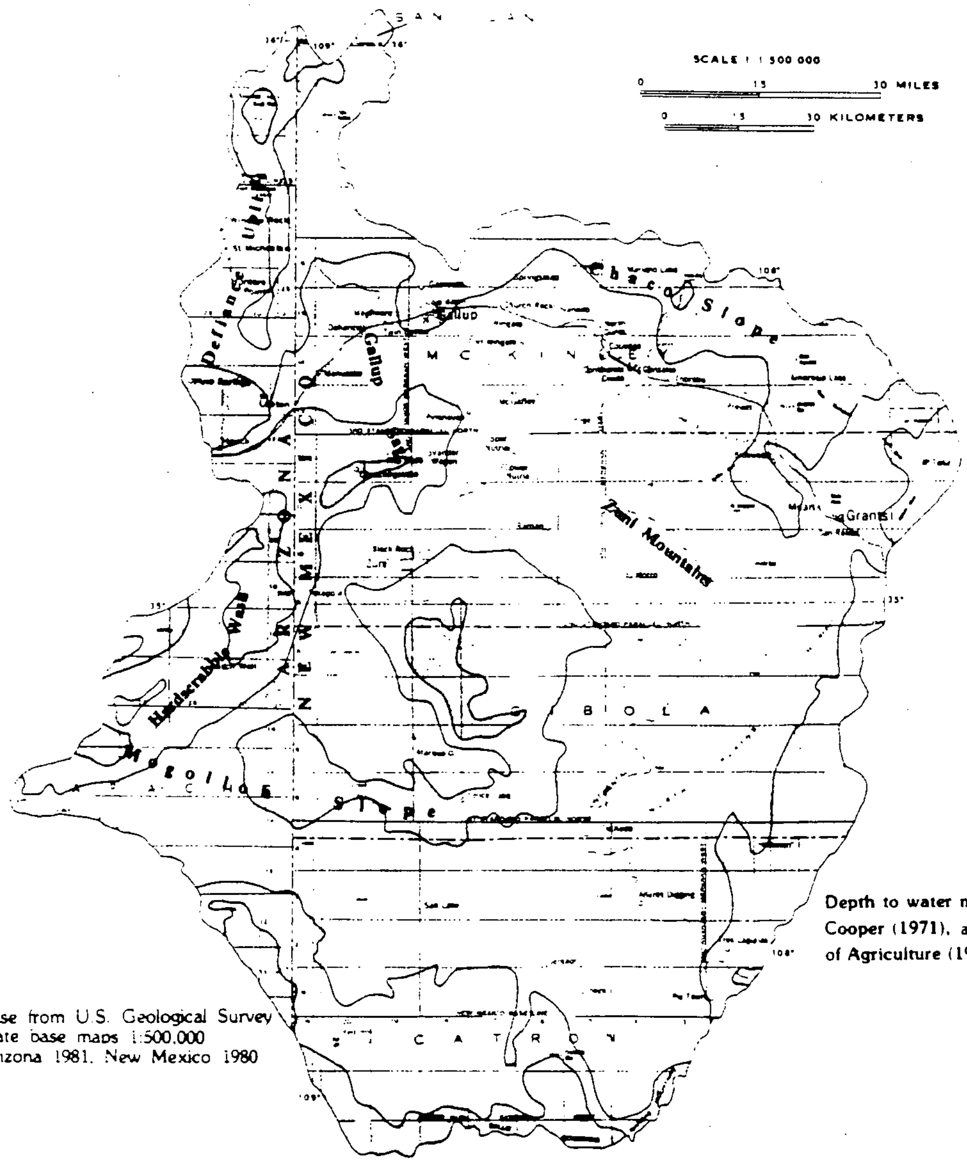
Depth to Water Below Land Surface Generally Less than 200 Feet

Depth to water varies because of complex geology and large topographic relief.

Depth to water ranges from only a few feet, especially along the major streams and rivers to about 500 feet along parts of the Defiance uplift, near Hardscrabble Wash south of the Defiance uplift, in the Gallup sag, and along the Mogollon slope on the southern boundary of the study area. Depths to water of less than 100 feet commonly occur in alluvial channels and in a few areas in Precambrian granite exposed southeast of Gallup, New Mexico, in the Zuni Mountains (fig. 2.6-1). Depth to water varies throughout the area because of the structural complexity of the geology and the substantial topographic relief. Generally, areas with similar depths to water roughly follow the physiographic and structural features of the area (Cooley and others, 1969, p. A-22).

Both artesian (confined) and water-table (unconfined) conditions occur in Area 62. Artesian conditions occur throughout the area and artesian springs and wells have been utilized in many areas (refer to figure 4.2-1 for the locations of major springs). Water-table conditions are present in the principal recharge areas (fig. 4.2-1), in the flat-lying rocks between major uplifts, and in the shallow alluvial aquifers along the major streams and rivers.

A generalized map of the depth to water in Area 62 is shown in figure 4.3-1. In specific areas, depth to water may differ considerably from the ranges indicated in this generalized map. The depth to water shown in figure 4.3-1 is the depth in feet below land surface, at which water is first penetrated, regardless of the quality, and is not the altitude to which the water will rise in a well. Data for figure 4.3-1 are from wells completed in the major aquifers (see section 4.5) and include data through 1980 for Apache County, Arizona (U.S. Department of Agriculture, 1981b), and through 1971 (Cooper, 1971) for counties in the New Mexico portion of Area 62.



Base from U.S. Geological Survey
State base maps 1:500,000
Arizona 1981, New Mexico 1980

Depth to water modified from:
Cooper (1971), and U.S. Department
of Agriculture (1981b).

EXPLANATION

DEPTH TO WATER, IN FEET BELOW LAND SURFACE

Less than 200

200 to 500

More than 500

Figure 4.3-1 General depth to ground water.

Water in Permian Aquifers has the Largest Median Concentrations of Dissolved Solids, Calcium, Sulfate, and Hardness

Water-quality data are summarized for 38 Jurassic sites, 68 Triassic sites, and 69 Permian sites.

Throughout much of Area 62, Jurassic through Permian aquifers underlie the coal-bearing rocks (fig. 4.5.3-1). The location of sampling sites for these aquifers is shown in figure 4.5.3-2; because of the map scale, one sampling site may represent several closely spaced wells or springs. A summary of the chemical analyses for samples is given in table 4.5.3-1.

The National Water Data Storage and Retrieval System (WATSTORE) lists 38 sites at which samples have been collected from Jurassic aquifers: 25 for the Morrison Formation, 8 for the combined Zuni Sandstone-Cow Springs Sandstone, and 5 for the Entrada Sandstone. Compared to other aquifers in Area 62, Jurassic aquifers exhibit small median concentrations of hardness and chloride.

Of the 68 Triassic sampling sites, 61 derive water from the Chinle Formation, 5 from the Wingate Sandstone, and 2 from the Moenkopi Formation. The water typically is enriched with bicarbonate and sodium but has small median concentrations of calcium and calcium carbonate hardness.

The summary of chemical analyses for Permian aquifers in table 4.5.3-1 is based on samples from two aquifer systems: the undifferentiated San Andres Limestone-Glorieta Sandstone in New Mexico (51 sites) and the undifferentiated Kaibab Limestone-Coconino Sandstone in Arizona (18 sites). As a group, the Permian aquifers have the most mineralized water in Area 62, with the largest median concentrations of hardness, calcium, sulfate, and dissolved solids; however, the sodium and chloride concentrations are rather small. Although the San Andres-Glorieta and Kaibab-Coconino are stratigraphically lateral equivalents, the available data indicate that water quality is markedly different in the units. Median concentrations of all constituents in the San Andres-Glorieta are much smaller than in the Kaibab-Coconino; especially notable are the concentrations of sodium (60 versus 360 milligrams per liter), chloride (22 versus 430 milligrams per liter), and dissolved solids (740 versus 1,750 milligrams per liter). These differences may be an aberration caused by the few samples available or the location of the sampling sites. However, the water-quality differences could be caused by differences in composition of the rocks or the chemical composition of the recharge to the aquifers.

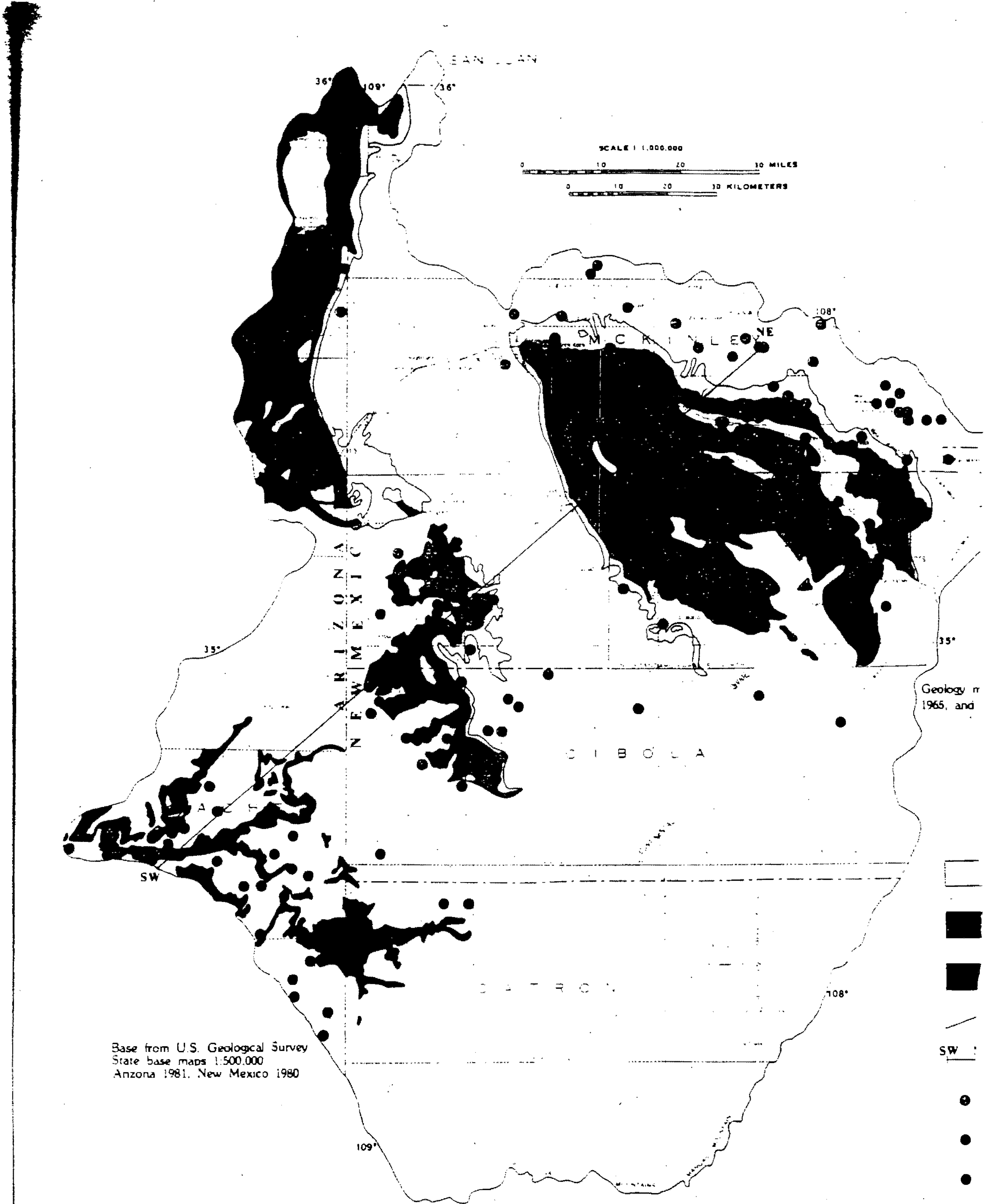


Figure 4.5.3-2 Sites of water samples from Jurassic, Triassic, and Permian

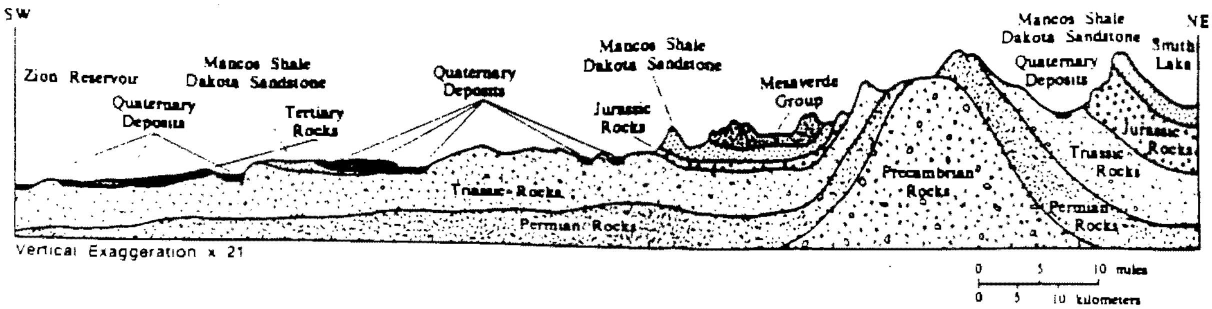


Figure 4.5.1-1 Schematic diagram showing stratigraphic relationship of Quaternary and Tertiary rocks to underlying rocks between Zion Reservoir and Smith Lake.

Table 4.5.1-1 Summary of chemical analyses of water samples from Quaternary and Tertiary aquifers.

Concentrations of dissolved constituents reported in milligrams per liter, except as indicated. Micromhos, micromhos per centimeter at 25° Celsius. < , less than.

Quaternary Aquifers

Constituent or property	Range	Median	Number of samples
Specific conductance (micromhos)	308-5,080	835	60
pH (units)	6.8-9.5	7.8	57
Bicarbonate (HCO_3)	140-670	320	41
Hardness ($CaCO_3$)	7-2,700	180	60
Calcium (Ca)	2.4-530	54	60
Sodium (Na)	8.5-1,000	120	50
Chloride (Cl)	2.9-1,100	26	60
Sulfate (SO_4)	0.8-2,600	84	60
Iron (Fe)	0-3.2	.024	50
Manganese (Mn)	< 1-1.0	.003	16
Dissolved solids	178-3,600	479	59

Constituent or property	Range	Median	Number of samples
Specific conductance (micromhos)	270-1,000	420	29
pH (units)	7.1-10.0	8.0	25
Bicarbonate (HCO_3)	82-330	153	19
Hardness ($CaCO_3$)	82-262	150	23
Calcium (Ca)	2.8-69	34	30
Sodium (Na)	8.0-230	40	30
Chloride (Cl)	4.2-130	14	30
Sulfate (SO_4)	4.8-95	14	30
Iron (Fe)	0-0.530	.020	29
Manganese (Mn)	0-0.120	.006	11
Dissolved solids	153-625	262	30

XPLANATION

OP AREA OF QUATERNARY ROCKS

OP AREA OF TERTIARY ROCKS

TACT

F SECTION (see figure 4.5.1-1)

E OF WATER SAMPLE FROM
ERNARY AQUIFER

F WATER SAMPLE FROM
RY AQUIFER

Well Yields Commonly as Much as 100 Gallons per Minute in Most of the Area

Consolidated sedimentary rocks store most of the ground water: permeability and depth to water affect the availability of ground water.

Wells completed in aquifers containing fresh to slightly saline water (dissolved solids concentration of less than 3,000 milligrams per liter) commonly yield as much as 100 gallons per minute. Yields of this magnitude can be obtained in more than one-half of the area (fig. 4.4-1). Water is obtained primarily from both consolidated sedimentary rocks and from unconsolidated stream-valley sediments and alluvium. Only a small amount of unconsolidated rocks are present in the area: therefore, the consolidated rocks store most of the ground water. Well yields in the unconsolidated rocks generally range from 100 to 500 gallons per minute. Yields in the consolidated rocks vary greatly because of differences in rock permeability. Most of the consolidated rocks yield from 25 to 100 gallons per minute. The use of ground water is affected economically by the depth from which it must be pumped.

Principal aquifers in the study area include the Permian Kaibab Limestone and Coconino Sandstone in Arizona, which grade laterally eastward to the San Andres Limestone and Glorieta Sandstone; the Triassic Chinle Formation; the Zuni Sandstone, members of the Morrison Formation, and the Entrada Sandstone and Summerville Formation of the San Rafael Group, all of Jurassic age; the Cretaceous Dakota Sandstone, Mancos Shale, Gallup Sandstone and formations in the Mesaverde Group; the Tertiary sediments of the Bidahochi Formation; and the stream-valley sediments of Tertiary to Quaternary age (table 2.7-1). Permeable volcanic rocks of Tertiary to Quaternary age yield water to wells locally.

The estimated potential yield for wells in Catron County is generally as much as 100 gallons per minute. Yields in Cibola and McKinley Counties are similar. Greater yields of as much as 500 gallons per minute are found around Gallup, north of Black Rock, and along the western edges of Cibola and Catron Counties. Well yields may exceed 500 gallons per minute around Bluewater in Cibola County. Studies by Mercer and Cooper (1970), Hiss and Marshall (1975), and McLean (1980) provide more detailed evaluations concerning the availability of ground water and potential yields in the Gallup area. Estimated potential yields in Apache County range widely from about 25 gallons per minute in the north to about 500 gallons per minute in the south.

Estimates for the volume of recoverable ground water are not available for the entire study area. The general location and estimated potential yields of ground water are shown in figure 4.4-1. Detailed investigations locally provide some information, but more data are needed to realize actual development of ground-water supplies (U.S. Department of Agriculture, 1981b).

Although the major water supply for rural-domestic, municipal, and industrial uses is ground water, water supply for livestock use is from both surface water and ground water (U.S. Department of Agriculture, 1981b, p.3-2). The U.S. Department of Agriculture (1981b, p. 3-14--3-20) estimated that future livestock water requirements will be increasing and that development of ground water is the best future source of water supply. Irrigation needs are served mostly by surface-water sources. In New Mexico and Arizona some of the wells for municipal, industrial, irrigation, rural domestic, and livestock use are completed in alluvial aquifers. Because these aquifers are generally thin and of limited saturated thickness, aquifers of Cretaceous age and older have been developed (refer to section 4.5 for major aquifers).

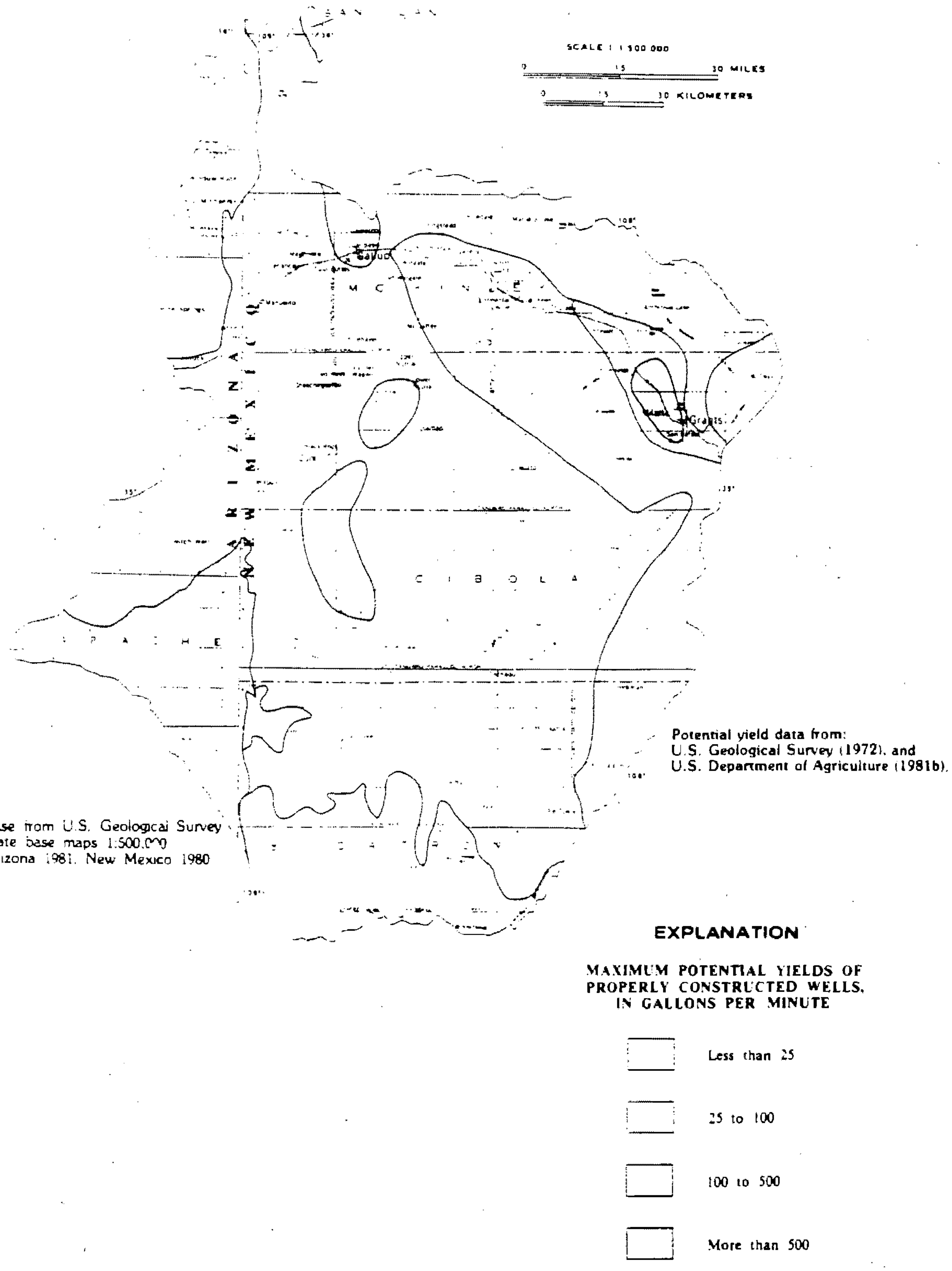


Figure 4.4-1 Estimated potential yield of water wells.

NAWDEX, WATSTORE, and OWDC Have Water Data Information

Water data are collected in coal areas by large number of organizations in response to a wide variety of missions and needs.

Within the U.S. Geological Survey there are three activities that help to identify and improve access to the vast amount of existing water data. These activities are:

(1) The National Water Data Exchange (NAWDEX), which indexes the water data available from over 400 organizations and serves as a central focal point to help those in need of water data to determine what information is available.

(2) The National Water Data Storage and Retrieval System (WATSTORE), which serves as the central repository of water data collected by the U.S. Geological Survey and which contains large volumes of data on the quantity and quality of both surface and ground waters.

(3) The Office of Water Data Coordination (OWDC), which coordinates Federal water-data acquisition activities and maintains a "Catalog of Information on Water Data." To assist in identifying available water-data activities in coal provinces of the United States, special indexes to the Catalog are being printed and made available to the public.

A more detailed explanation of these three activities are given in sections 5.2, 5.3, and 5.4.

REFERENCE # 6

NAVAJO SUPERFUND OFFICE

BROWN VANDEVER URAN-
IUM MINE REFERENCE
MATERIAL

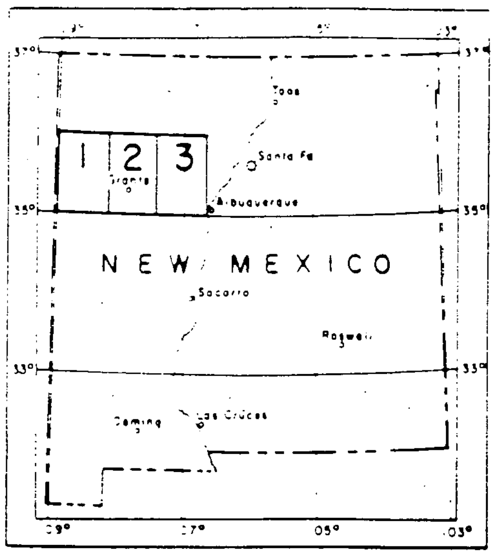
MAY, '90 P. MOLLOY

17:6

$5.00

Geologic Map of Grants Uranium Region

Maps #1 + 2 frame in Plane sleeve



GEOLOGIC MAP 31 New Mexico Bureau of Mines & Mineral Resources 1974

A DIVISION OF

NEW MEXICO INSTITUTE OF MINING & TECHNOLOGY


Jm
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24
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PIPELINE
SANTA FE
FAI 40
40
66
412
Jm
Kdm
NAVAJO INDIAN LAND
LAVA FLOW
Qv
BLUE WATER STATE PARK
P
UD
Bluewater
Anaconda
334
Broadview
FAS 1302
53
Tv
FOREST
Canyon
Pole
FAP 3
SANTA FE

EOLOGIC MAP 31 1 2 3 SHEET 3 OF 3

R.2E. R. 3E.

EXPLANATION

TERTIARY & QUATERNARY — T.20N.

Qv

Tv

Undifferentiated volcanic rocks, mostly basaltic; locally includes intrusive rocks

UNCONFORMITY

TERTIARY

Tb | Tc

Continental strata; Bidahochi Formation and Chuska Sandstone

UNCONFORMITY

T.19N.

CRETACEOUS

Mesaverde Group

Kck

Cliff House Sandstone, Lewis Shale, Pictured Cliffs Sandstone, Fruitland Formation, and Kirtland Shale; includes Tertiary strata in T. 20 N.

Kpm

Point Lookout Sandstone and Menefee Formation; includes Hosta Sandstone and Satan Tongue of Mancos Shale, where present

T.18N.

Kgc

Gallup Sandstone and overlying Crevasse Canyon Formation (in south part of map area) and Mulatto Tongue of Mancos Shale (in north part of map area)

Dakota Formation and lower Mancos Shale

UNCONFORMITY

T.17N.

Jmj / Jm

Morrison Formation. In ascending order: Recapture Shale Member (at base), Westwater Canyon Member, and Brushy Basin Member. Jackpile Sandstone (Jmj) of Brushy Basin Member mapped separately in Laguna area

J

Jurassic strata beneath Morrison Formation. Includes Entrada Sandstone, Todilto Formation, and Summerville Formation of San Rafael Group and overlying Cow Springs Sandstone with its lateral equivalents, Zuni Sandstone and Bluff Sandstone

UPPER JURASSIC

UNCONFORMITY

T.16N.

Ꞧ

Triassic strata, undifferentiated. Includes Chinle Formation and Wingate Sandstone

TRIASSIC

UNCONFORMITY

P

Permian strata, undifferentiated. Includes Abo Formation, Yeso Formation, Glorieta Sandstone, and San Andres Limestone

PERMIAN

T.15N.

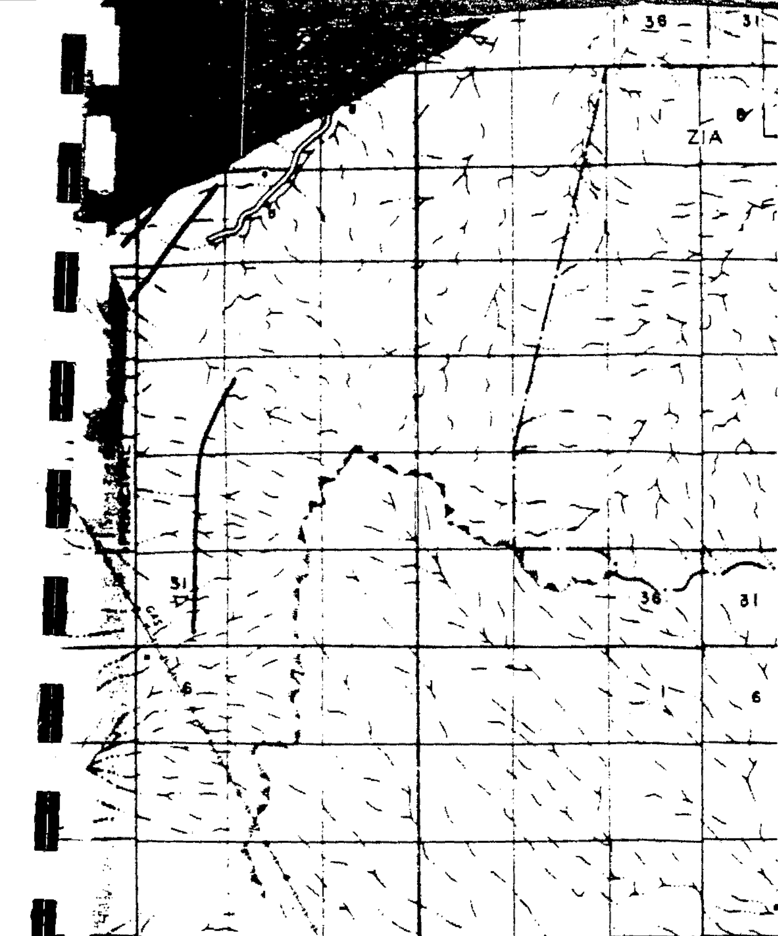
P

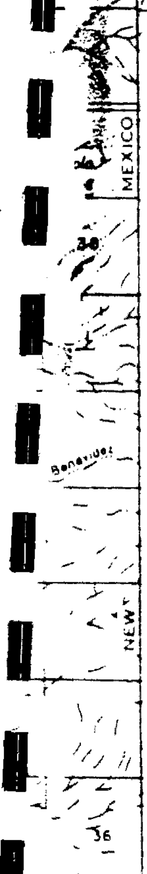
Pennsylvanian rocks, undifferentiated. Includes Sandia Formation and Madera Limestone

PENNSYLVANIAN

UNCONFORMITY

BRIAN



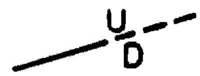


UNCONFORMITY

Precambrian rocks, undifferentiated. Includes granitic rocks and, in Zuni Mountains, several types of metamorphic rocks

PRECAMBRIAN

Contacts, dashed where approximate

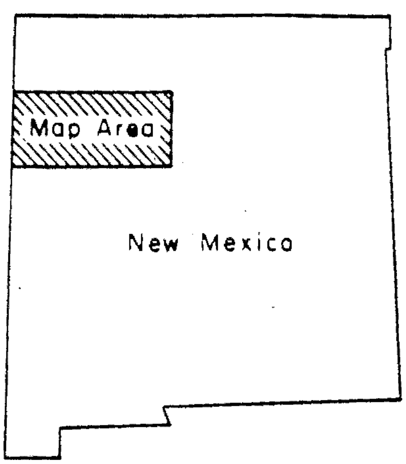


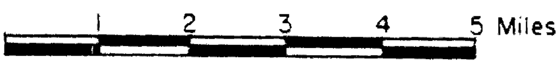
Fault or fault zone, dashed where approximate

Uranium deposits in Morrison Fm, of known shape and extent

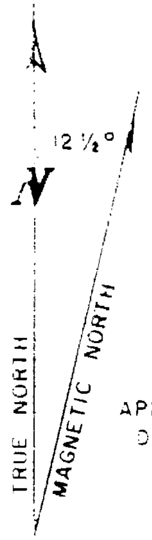
Locality of close-spaced drilling indicating uranium mineralization in Morrison Formation

623-6951





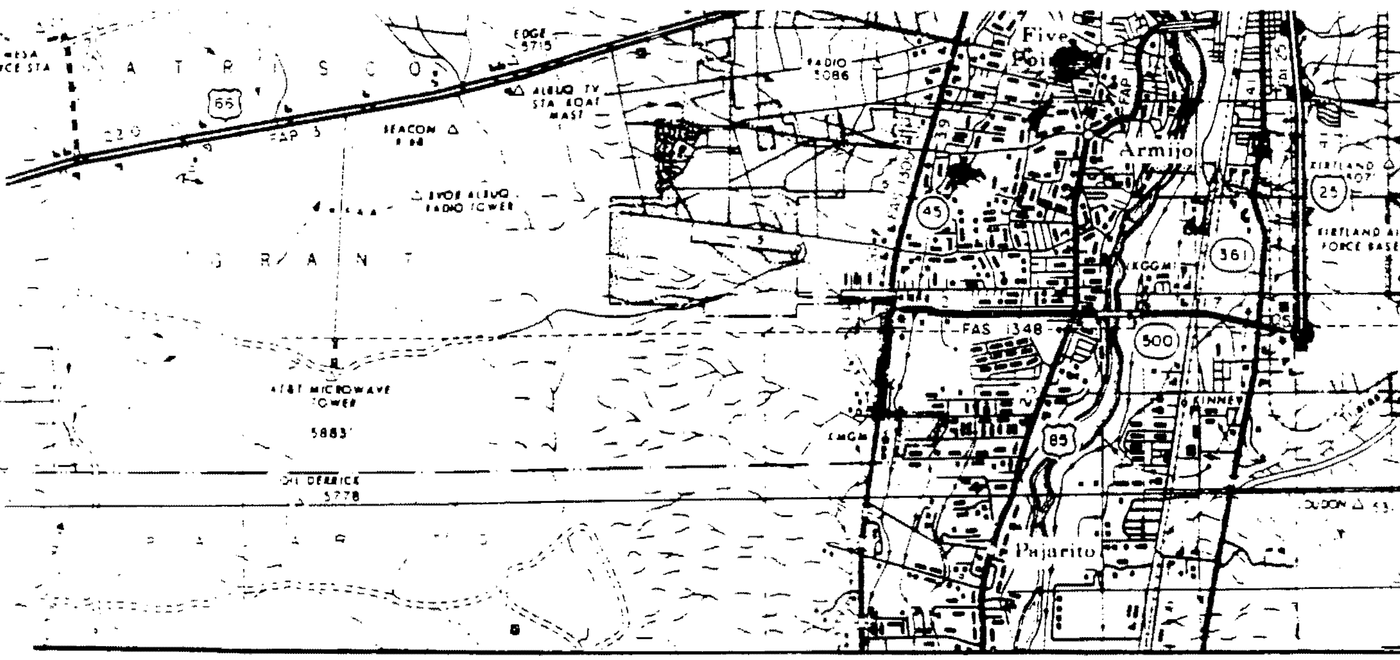
Base map by New Mexico State Highway Department. Geology compiled from sources listed on Sheet I.



APPROXIMATE MEAN
DECLINATION, 1972

T.11N.

T.10N.



T.9N.

R.1E. R.2E. R.3E.

GEOLOGIC MAP 31 1 2 3 SHEET 3 OF 3

R.1E. R.2E. R.3E.

R8W. R.7W. R.6W.

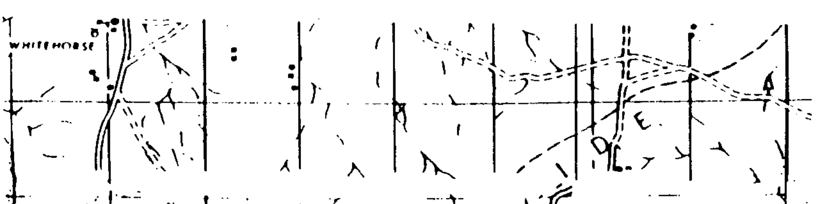
DICATED SUBSTANTIAL URANIUM
RALIZATION IN MORRISON FORMATION

NAME	OWNER
....	Gulf
Section 24	Gulf
Fernandez	Gulf
Melrich	Homestake
....	Enerdyne
Johnny M	Ranchers
Section 19	Keradamex/Gulf
Walker Dome	Gulf
....	DeVilliers
....	DeVilliers
....	United Nuclear
....	Western Nuclear/N. M. Ariz. Land
Ruby Wells	Western Nuclear/N. M. Ariz. Land
....	Western Nuclear/N. M. Ariz. Land

(continued on sheets 1 and 3)

SEE SHEET 3 FOR EXPLANATION

SEE BACK OF SHEET 3 FOR TEXT



MAJOR MORRISON FORMATION URANIUM MINES

MAP NO.	NAME	OPERATOR
1	Poison Canyon	(First sandstone uranium discovery in region, 1951)
2	Dysart No. 1	(First Westwater Sandstone uranium discovery, 1955)
7	San Mateo	United Nuclear
8	Cliffside	Kerr-McGee
9	Elizabeth	Kerr-McGee
10	Marquez	Kerr-McGee
11	Section 27	United Nuclear
12	Section 27 #2	United Nuclear
13	Sandstone	Kerr-McGee
14	Ann Lee	United Nuclear
15	Section 33	Kerr-McGee
16	Section 17	Kerr-McGee
17	Section 32	United Nuclear-Homestake
18	Section 19	Kerr-McGee
19	Section 30 West	Kerr-McGee
20	Section 30	Kerr-McGee
21	Section 24	Kerr-McGee
22	Section 25	United Nuclear-Homestake
23	Section 23	United Nuclear-Homestake
24	Section 15	United Nuclear-Homestake
25	Section 22	Kerr-McGee
26	Black Jack #1	United Nuclear-Homestake

(continued on sheets 1 and 3)

T.20N.
T.19N.
T.18N.

REFERENCE # 8

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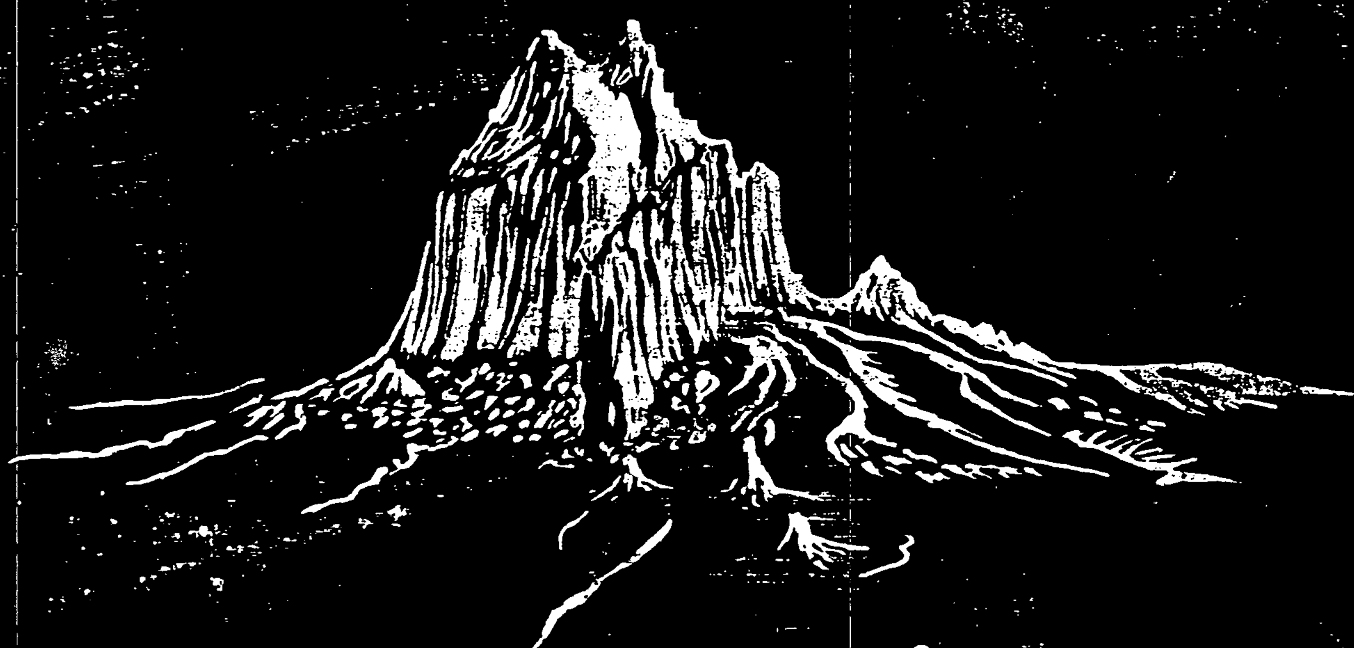
BROWN VANDEVER URANIUM MINE REFERENCE MATERIAL

MAY, '90 P. MOLLOY

NEW MEXICO GEOLOGICAL SOCIETY



San Juan Basin III

1977

Guidebook of

San Juan Basin III

NORTHWESTERN NEW MEXICO

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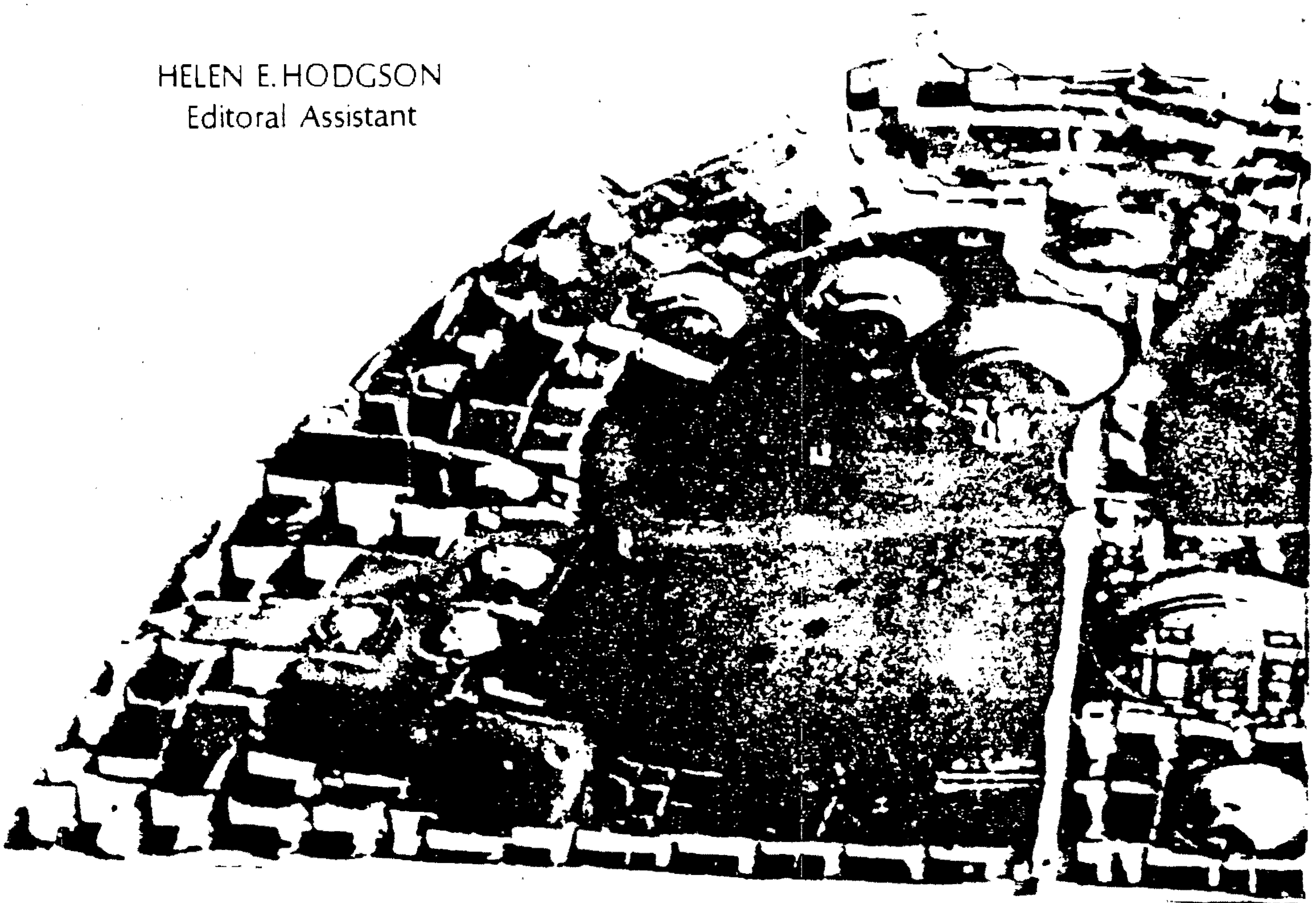
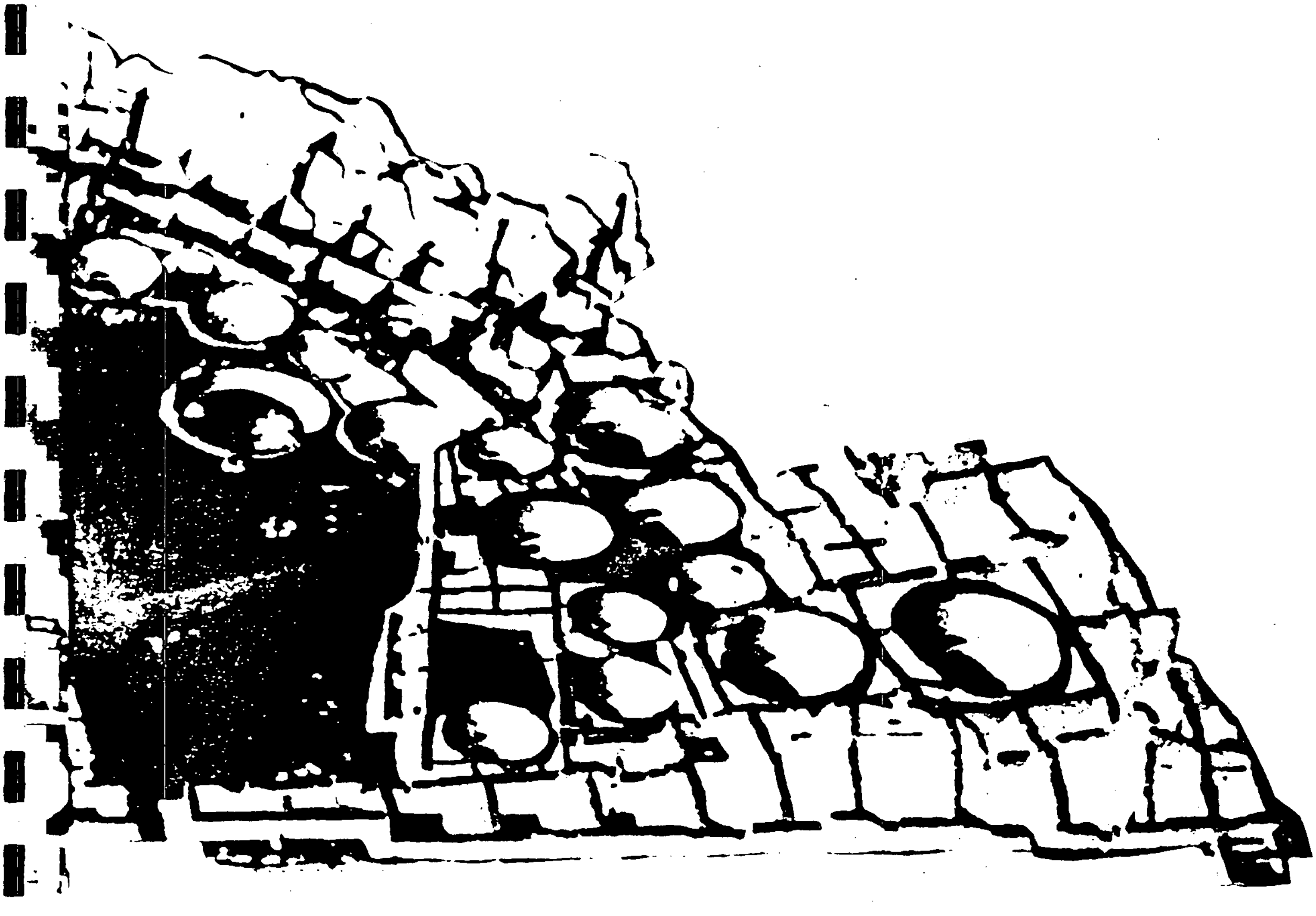
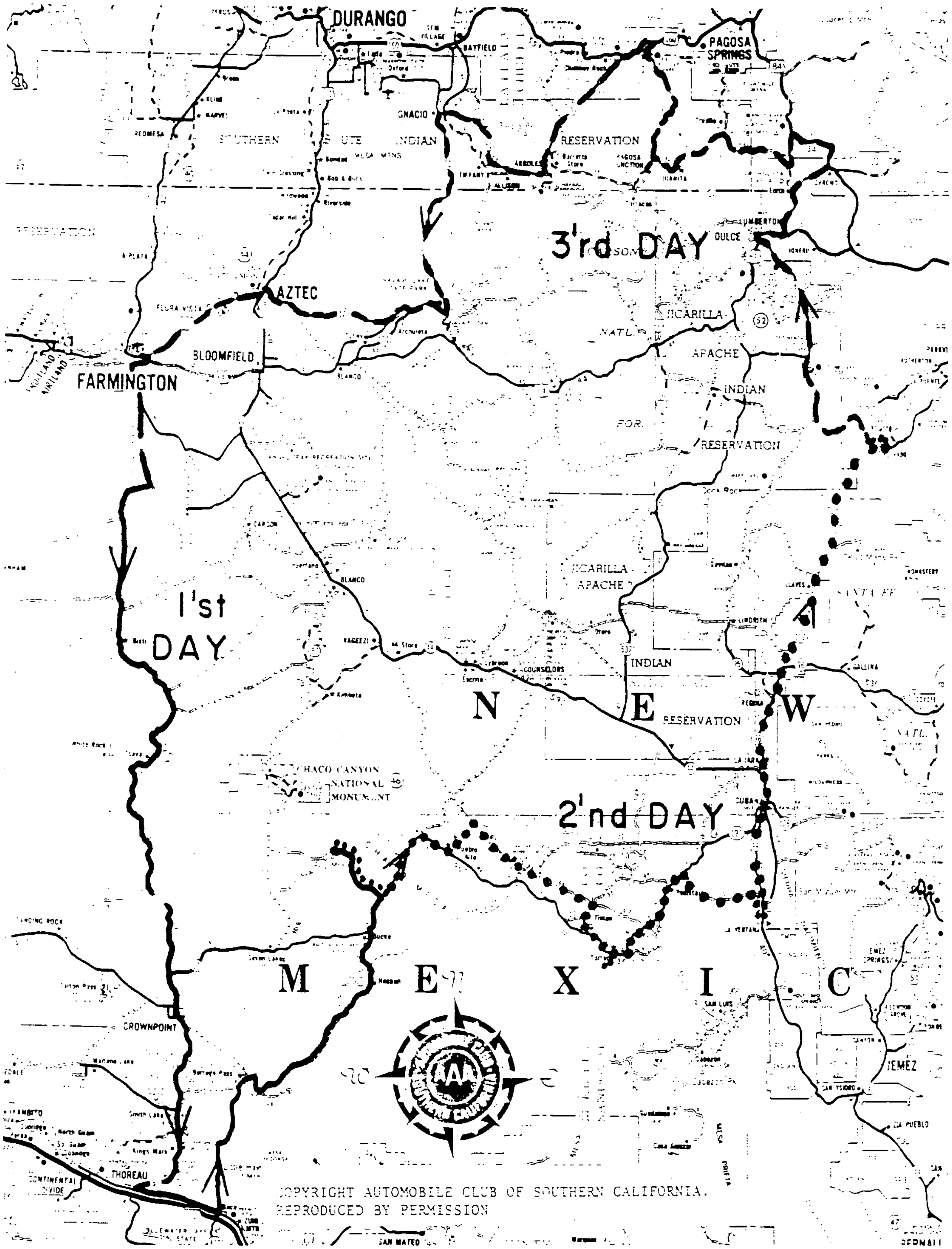


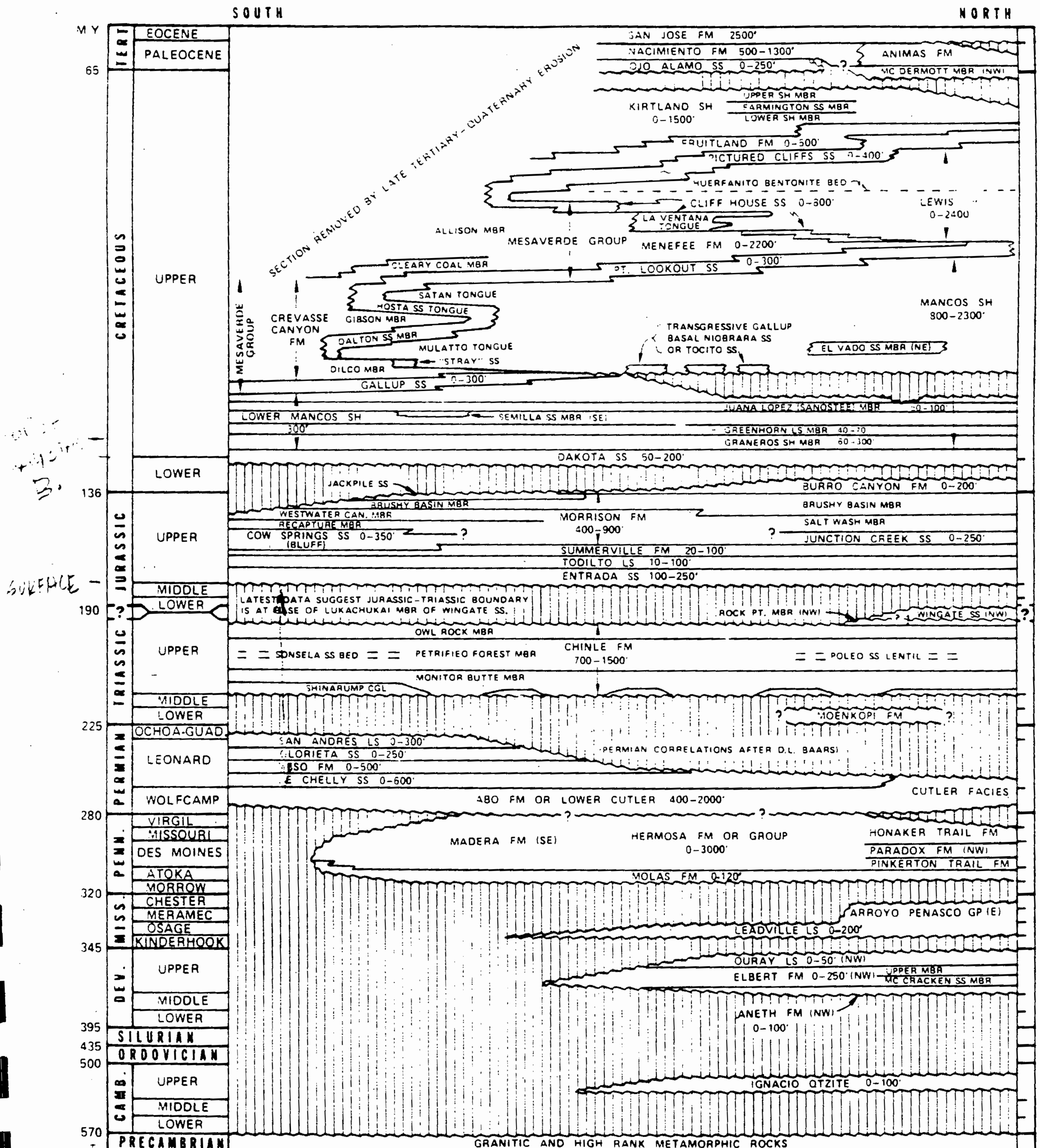
New Mexico Geological Society
Twenty-Eighth Field Conference
September 15-17, 1977





DURANGO
BAYFIELD
PAGOSA SPRINGS
SOUTHERN UTE INDIAN
RESERVATION
3'rd DAY
DULCE
LUMBERTON
AZTEC
JICARILLA
APACHE
INDIAN
RESERVATION
BLOOMFIELD
FARMINGTON
BLANCO
1'st DAY
JICARILLA APACHE
INDIAN
RESERVATION
N E W
M E X I C
CHACO CANYON NATIONAL MONUMENT
2'nd DAY
CUBA
CROWNPOINT
THOREAU
JEMEZ
CONTINENTAL DIVIDE

SAN JUAN BASIN TIME-STRATIGRAPHIC NOMENCLATURE CHART



COMPILED BY C.M. MOLENAAR 1977

101.0 Dakota-Morrison contact on right.

0.6

101.6 On left ahead is the Todilto Limestone overlying the Entrada Sandstone.

0.5

102.1 Road to the left leads to a quarry in the Todilto Limestone. The limestone is mined or quarried for aggregate which was used for construction of Interstate Highway 40 in eastern Arizona. The Todilto outcrop immediately right (west) of the road is the type locality for the ostracode *Metacypris todiltensis*. This new species is said to be definitely nonmarine and have the following dimensions: 0.65 mm. long, 0.50 mm. high, and 0.35 mm. thick. Road ahead cuts down through the Entrada.

1.0

103.1 Contact of the Entrada Sandstone and Chinle Formation is exposed at the base of the hill at 2:00. The Chinle is the soft-weathering, purplish shaly unit.

2.5

105.6 **STOP 3**—Discussion of the Mesozoic section exposed on cliffs. The Owl Rock Member of the Chinle Formation (Upper Triassic) is poorly exposed at the base of the cliff. The Owl Rock is unconformably overlain by the Entrada Sandstone of Late Jurassic age. The Entrada is about 250 feet thick here and has been divided into three parts on U.S.G.S. quadrangle maps in this area. The lower 50± feet is called the Ivanbito Member and is a cross-bedded sandstone unit that formerly was considered to be Wingate Sandstone. Above this is a 50±-foot-thick medial silt-

Figure 105.6. View to southwest near Stop 3 illustrating the contacts of the Entrada Sandstone (Je) with the Todilto Limestone (Jt) and the underlying Chinle Formation (Rc)—H. L. James photo.

stone member, and then the main thick upper sandstone member. The Entrada is an eolian deposit.

The Entrada is overlain by the 10 to 40-foot-thick Todilto Limestone. The slope-former above this is the Summerville Formation which is about 60 feet thick and consists of reddish brown to orange silty sandstone and siltstone. The overlying Cow Springs Sandstone is divided into a lower unit made up of cosets of medium scale cross-bedded sandstone and flat bedded silty sandstone and an upper thick, light greenish gray unit consisting of large scale, eolian cross-bedded sandstone. The Cow Springs has also been called Bluff or Zuni Sandstone and Thoreau Formation.

The Morrison conformably overlies the Cow Springs and is divided into three members which in ascending order are: (1) Recapture Member, an interbedded reddish brown siltstone and light gray sandstone unit; (2) Westwater Canyon Member a thick, light red fluvial sandstone unit; and (3) Brushy Basin Member, a slope forming unit of greenish to purplish gray shale and sandstone. In earlier mapping, Clay Smith named these three members, in ascending order: Chavez, Prewitt and Casamero members. An unconformity is present either at the base of the Morrison or within the Recapture Member. The Westwater Canyon Member is the major uranium producer in the Grants mineral belt. The Todilto Limestone and fluvial sands in the Brushy Basin are also productive.

The brown unit capping the hill is the basal fluvial sandstone of the Dakota, which unconformably overlies the Morrison. The Dakota truncates the section to the south overlying the Chinle Formation south of the Zuni uplift.

The unconformity at the base of the Entrada is a regional unconformity in which the Entrada and associated Carmel Formation overlie progressively older strata from west to east across the Colorado Plateau; one might call this the craton's response to early Nevadan orogeny.

An interesting bit of nomenclatural history concerns the type area of the Wingate Sandstone. This is at the Wingate cliffs; a continuation of these cliffs extend about 22 miles to the west near Fort Wingate, New Mexico. After the Wingate place name was applied in New Mexico, the Wingate nomenclature became firmly entrenched in the literature of southeastern Utah for a sandstone bed which apparently does not exist at the type locality. When it was realized that the type Wingate was actually the Entrada Sandstone of southeastern Utah, for some reason, the first reference and type locality did not take precedence. Ever since, some workers have tried to include a part of the Wingate in the original Wingate (now Entrada) cliffs, but regional correlations show the Wingate truncated edge is far to the west near the Arizona-New Mexico border. The Wingate is present in the northwest corner of New Mexico. Incidentally, the Wingate, which was originally considered to be Early Jurassic in age and later was thought to be Late Triassic, is now considered Early Jurassic in age on the basis of palynomorphs found in the time-equivalent Moenave Formation in south-central Utah. Those paleontologists are a shifty bunch!

1.5

107.1 Thoreau Chapter House on right.

1.3

108.4 Cross Santa Fe Railroad tracks.

0.2

108.6 Turn left on frontage road; do not go under I-40! After turn, Mt. Taylor is straight ahead. On right is dip slope of Chinle (largely Sonsela Sandstone Bed) off Zuni uplift to southwest.

2.8

111.4 On left at 9:00 is good view of cliff exposures from Chinle to Dakota. Light green, massive sandstone about half way up is eolian Cow Springs Sandstone. Refer to mile 105.6 for discussion.

2.2

113.6 Roadcut in Chinle. Haystack Butte is straight ahead. This is the location where Paddy Martinez, a Navajo sheepherder, collected samples of the Todilto Limestone containing yellow uranium minerals. Publicity associated with the find started the uranium boom in the Grants area in the fall of 1950.

3.7

117.3 Roadcut in Chinle (Sonsela Sandstone Bed).

1.0

118.3 Road junction with N.M. 412; continue straight ahead.

0.5

118.8 KOA Campground on right and road junction on left; turn left toward Borrego Pass. This is Baca—the point where a proposed railroad spur will head north to Star Lake to bring down coal to the Santa Fe's main line from

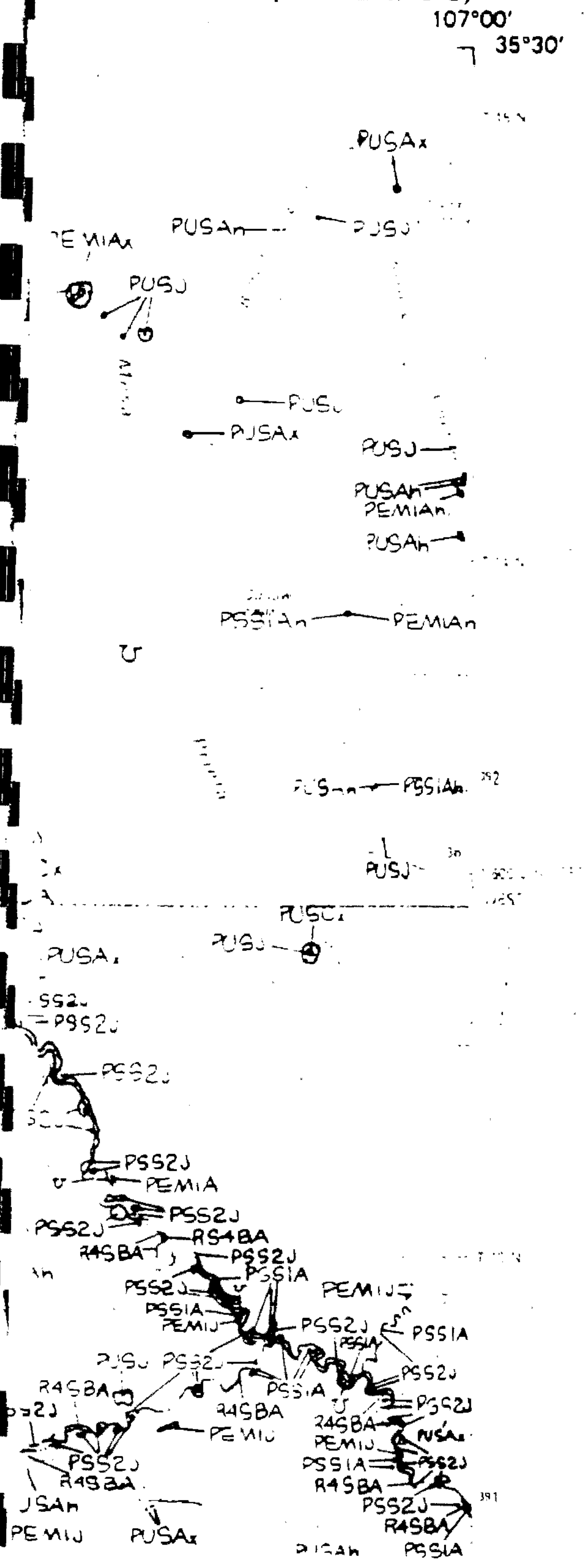
REFERENCE # 9

NAVAJO SUPERFUND OFFICE

BROWN VANDEVER URANIUM MINE REFERENCE MATERIAL

MAY, '90 P. MOLLOY

.UTE SERIES (WETLANDS)



Grants

NEW MEXICO

1:100 000 — Scale Map of

National Wetlands Inventory

- Wetland classifications
- Highways, roads and other manmade structures
- Water features
- Geographic names

U.S. DEPARTMENT OF THE INTERIOR MARCH 3, 1849

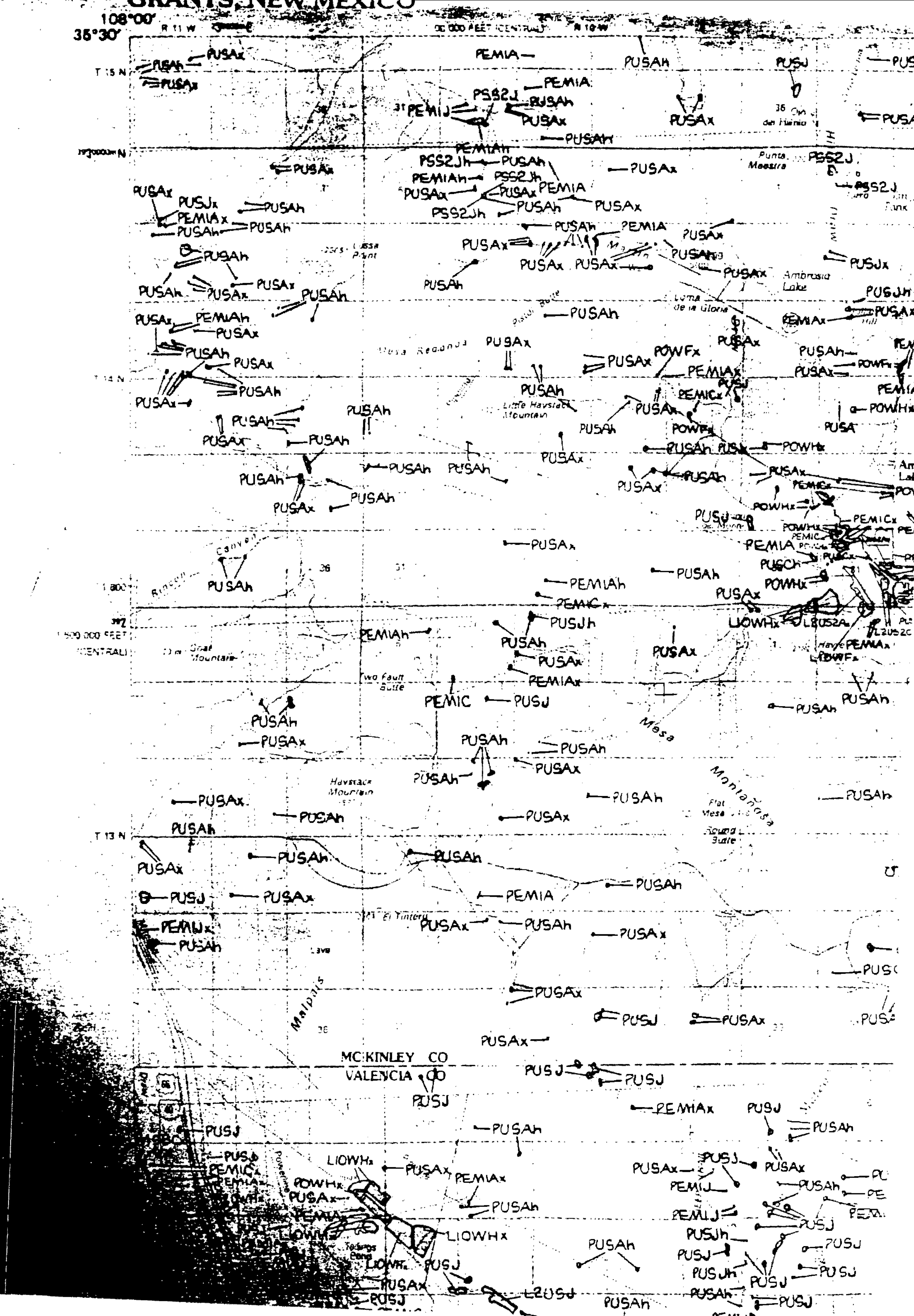
FISH & WILDLIFE SERVICE

1984

Produced by the United States Fish and Wildlife Service

Wetland classifications from 1:58,000 scale color infrared aerial photographs taken 1981 and other source data.

Projection and 10,000 meter, zone 12
Universal Transverse Mercator
25,000-foot grid ticks based on New Mexico coordinate system, central and east zones 1927 North American datum


GRANTS, NEW MEXICO
108°00'
35°30'
R 11 W
R 10 W
T 15 N
T 14 N
T 13 N
1 500 000 FEET (CENTRAL)
Ojo del Hierro
Punta Maestra
Loma de la Gloria
Ambrosia Lake
Mesa Redonda
Little Haystack Mountain
Rincon
Canyon
Goat Mountain
Two Fault Butte
Haystack Mountain
Mesa Montañosa
Flat Mesa
Round Butte
El Tintero
Malpais
Lava
MCKINLEY CO
VALENCIA CO
Powerline
Todilto Park
PEMIA
PUSAh
PUSAx
PUSJ
PUSJx
PUSJh
PSS2J
PSS2Jh
PEMIJ
PEMIAh
PEMIAx
PEMIC
PEMICx
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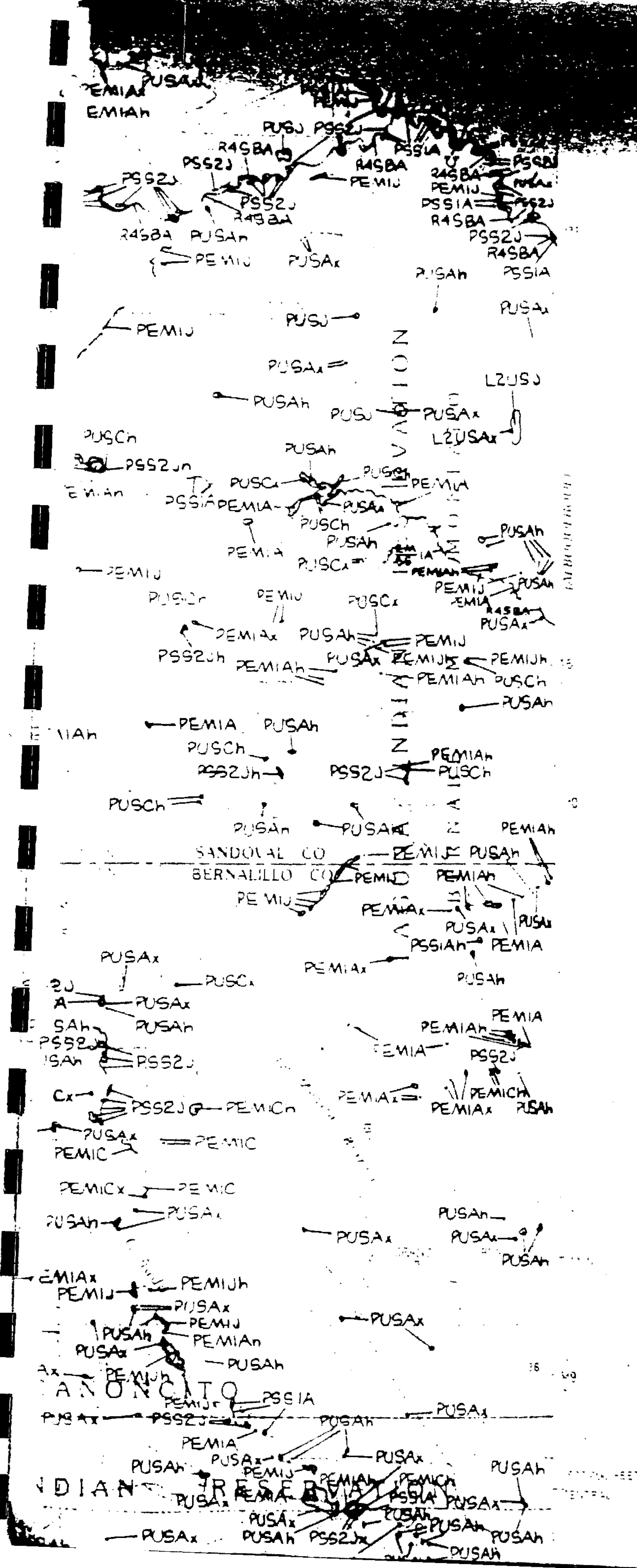
L2USJ
L2US2A
L2US2C
PUSA



Projection and 10,000 meter, zone 12
Universal Transverse Mercator
25,000-foot grid ticks based on New Mexico coordinate system, central and east zones 1927 North American datum
To place on the predicted North American Datum 1983 move the projection line 1 meter south and 54 meters east

SPECIAL NOTE

This document was prepared primarily by stereoscopic analysis of high altitude aer[ial] photographs. Wetlands were identified on the photographs based on vegetation, visi[ble] hydrology, and geography in accordance with **Classification of Wetlands and Deep Wa[ter] Habitats of the United States** (An Operational Draft) Cowardin, et al, 1977. The aer[ial] photographs typically reflect conditions during the specific year and season when th[ey] were taken. In addition, there is a margin of error inherent in the use of the aer[ial] photographs. Thus, a detailed on the ground and historical analysis of a single site m[ay] result in a revision of the wetland boundaries established through photographic interpre[ta]tion. In addition, some small wetlands and those obscured by dense forest cover may not [be] included on this document.

Federal, State and local regulatory agencies with jurisdiction over wetlands may de[fine] and describe wetlands in a different manner than that used in this inventory. There is [no] attempt, in either the design or products of this inventory, to define the limits of propriet[ary] jurisdiction of any Federal, State or local government or to establish the geographical sco[pe] of the regulatory programs of government agencies. Persons intending to engage [in] activities involving modifications within or adjacent to wetland areas should seek the adv[ice] of appropriate Federal, State or local agencies concerning specific agency regulat[ory] programs and proprietary jurisdictions that may affect such activities.

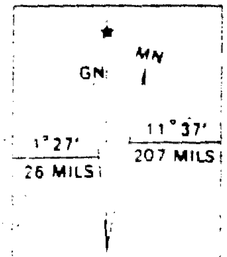
CONVERSION TABLE

Meters	Feet
1	3.2808
2	6.5617
3	9.8425
4	13.1234
5	16.4042
6	19.6850
7	22.9659
8	26.2467
9	29.5276
10	32.8084

To convert meters to feet multiply by 3.2808

To convert feet to meters multiply by 0.3048

DECLINATION DIAGRAM



UTM grid convergence (GN) and 1984 magnetic declination (MN) at center of map
Diagram is approximate

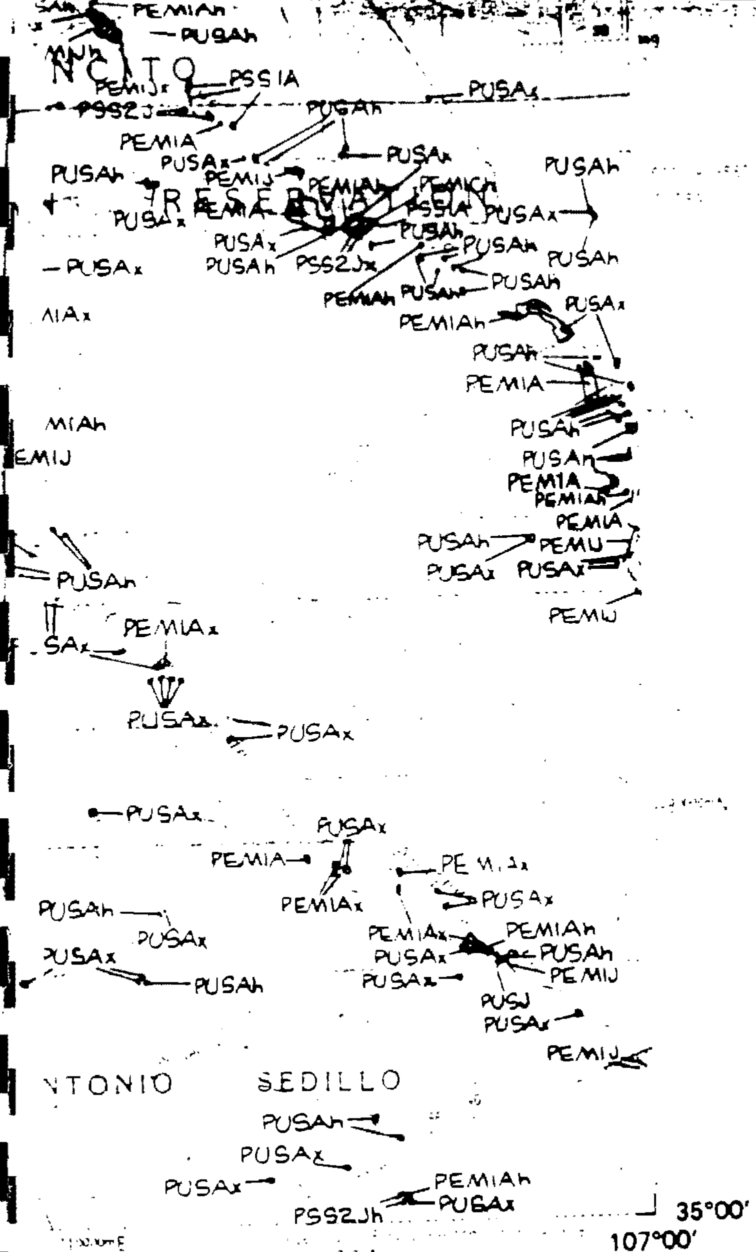
ADJOINING MAPS

1	2	3
4		5
6	7	8

1. Gallup
2. Chaco Mesa
3. Los Alamos
4. Zuni
5. Albuquerque
6. Fence Lake
7. Acoma Pueblo
8. Belen

NOTES TO THE USER

- Wetlands which have been field examined are indicated on the map by an asterisk (*).
- Additions or corrections to the wetlands information displayed on this map are solicited. Please forward suc[h] information to the address indicated.
- Subsystems, Classes, Subclasses, and Water Regimes in *italics* were developed specifically for NATIONAL WETLANDS INVENTORY mapping.
- Some areas designated as R4SB, R4SBW, OR R4SBJ (INTERMITTENT STREAMS) may not meet the definition of wetland.



NOTES TO THE USER
- Wetlands which have been field examined are indicated on the map by an asterisk (*).
- Additions or corrections to the wetlands information displayed on this map are solicited. Please forward such information to the address indicated.
- Subsystems, Classes, Subclasses, and Water Regimes in *italics* were developed specifically for NATIONAL WETLANDS INVENTORY mapping.
- Some areas designated as R4SB, R4SBW, OR R4SBJ (INTERMITTENT STREAMS) may not meet the definition of wetland.
- This map uses the class Unconsolidated Shore (US). On earlier NWI maps that class was designated Beach/Bar (BB), or Flat (FL). Subclasses remain the same in both versions.

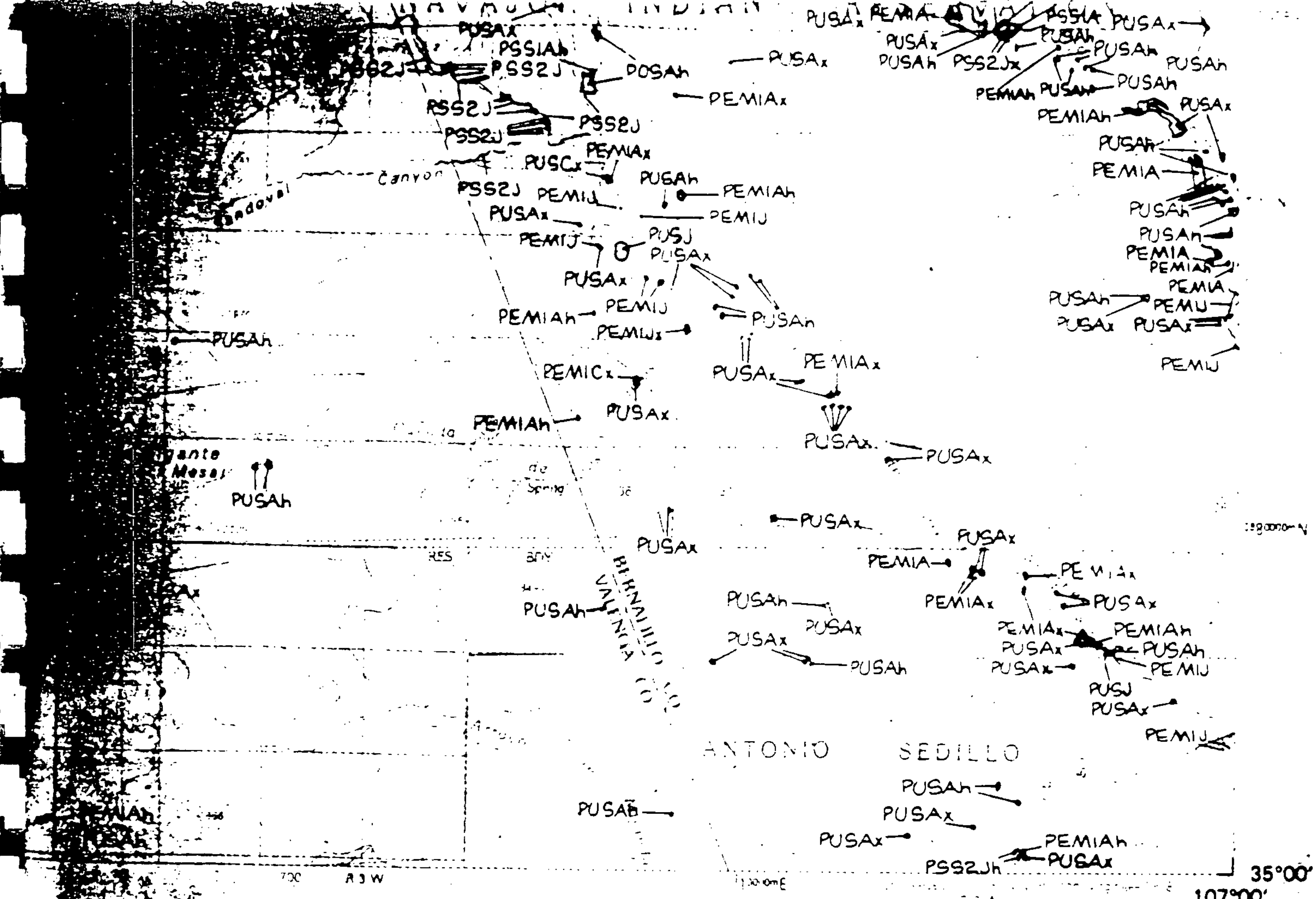
Other information including a narrative report concerning the wetland resources depicted on this document may be available. For information, contact:

Regional Director (ARDE) Region II U.S. Fish and Wildlife Service
P.O. Box 1306 Albuquerque, New Mexico 87103

GRANTS, NEW MEXICO
(SW ¼ of Albuquerque 1:250,000)

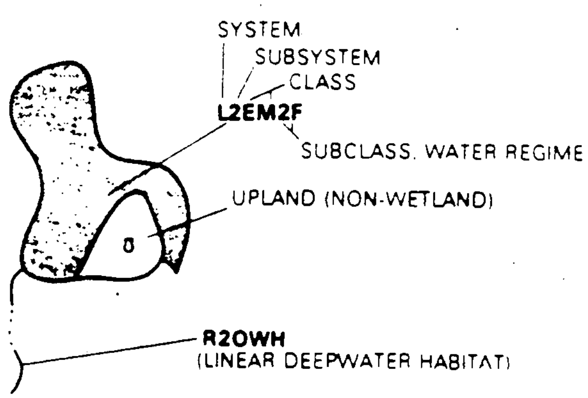
GIME

ay include
areas, non
al omissions.

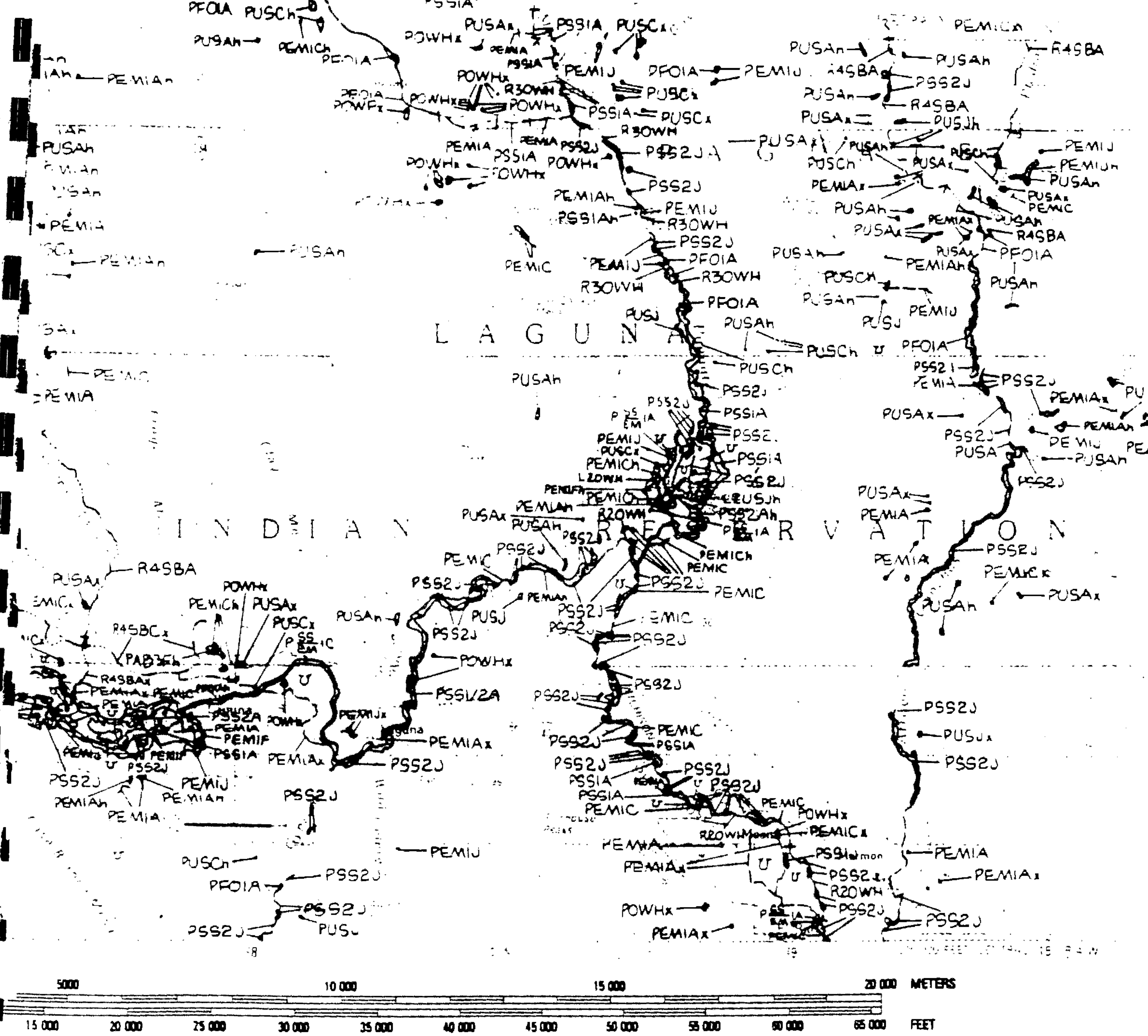


GRANTS, NEW MEXICO
(SW ¼ of Albuquerque 1:250,000)

SYMBOLOGY EXAMPLE



Ʊ — Primarily represents upland areas, but may include unclassified wetlands such as man-modified areas, non photo-identifiable areas and/or unintentional omissions.



L — LACUSTRINE

1 — LIMNETIC

RB — ROCK BOTTOM
1 Bedrock
2 Rubble

UB — UNCONSOLIDATED BOTTOM
1 Cobble-Gravel
2 Sand
3 Mud
4 Organic

AB — AQUATIC BED
1 Algal
2 Aquatic Moss
3 Rooted Vascular
4 Floating Vascular
5 Unknown Submergent
6 Unknown Surface

OW — OPEN WATER/ Unknown Bottom

2 — LITTORAL

RB — ROCK BOTTOM
1 Bedrock
2 Rubble

UB — UNCONSOLIDATED BOTTOM
1 Cobble-Gravel
2 Sand
3 Mud
4 Organic

AB — AQUATIC BED
1 Algal
2 Aquatic Moss
3 Rooted Vascular
4 Floating Vascular
5 Unknown Submergent
6 Unknown Surface

RS — ROCKY SHORE
1 Bedrock
2 Rubble

US — UNCONSOLIDATED SHORE
1 Cobble-Gravel
2 Sand
3 Mud
4 Organic
5 Vegetated

EM — EMER[GENT]
2 Nonpersistent

MODIFIERS

In order to more adequately describe wetland and deepwater habitats one or more of the water regime, water chemistry, soil, or special modifiers may be applied at the class or lower level in the hierarchy. The farmed modifier may also be applied to the ecological system.

WATER REGIME

Non-Tidal

A Temporarily Flooded
B Saturated
C Seasonally Flooded
D Seasonally Flooded/Well Drained
E Seasonally Flooded/Saturated
F Semipermanently Flooded
G Intermittently Exposed
H Permanently Flooded
J Intermittently Flooded
K Artificially Flooded
W Intermittently Flooded/Temporary
Y Saturated/Semipermanent/Seasonal
Z Intermittently Exposed/Permanent
U Unknown

Tidal

K Artificially Flooded
L Subtidal
M Irregularly Exposed
N Regularly Flooded
P Irregularly Flooded
*S Temporary-Tidal
*R Seasonal-Tidal
*T Semipermanent-Tidal
*V Permanent-Tidal
U Unknown

*These water regimes are only used in tidally influenced, freshwater systems.

WATER CHEMISTRY

Coastal Halinity
1 Hyperhaline
2 Euhaline
3 Mixohaline (Brackish)
4 Polyhaline
5 Mesohaline
6 Oligohaline
0 Fresh

Inland Salinity
7 Hypersaline
8 Eusaline
9 Mixosaline
0 Fresh

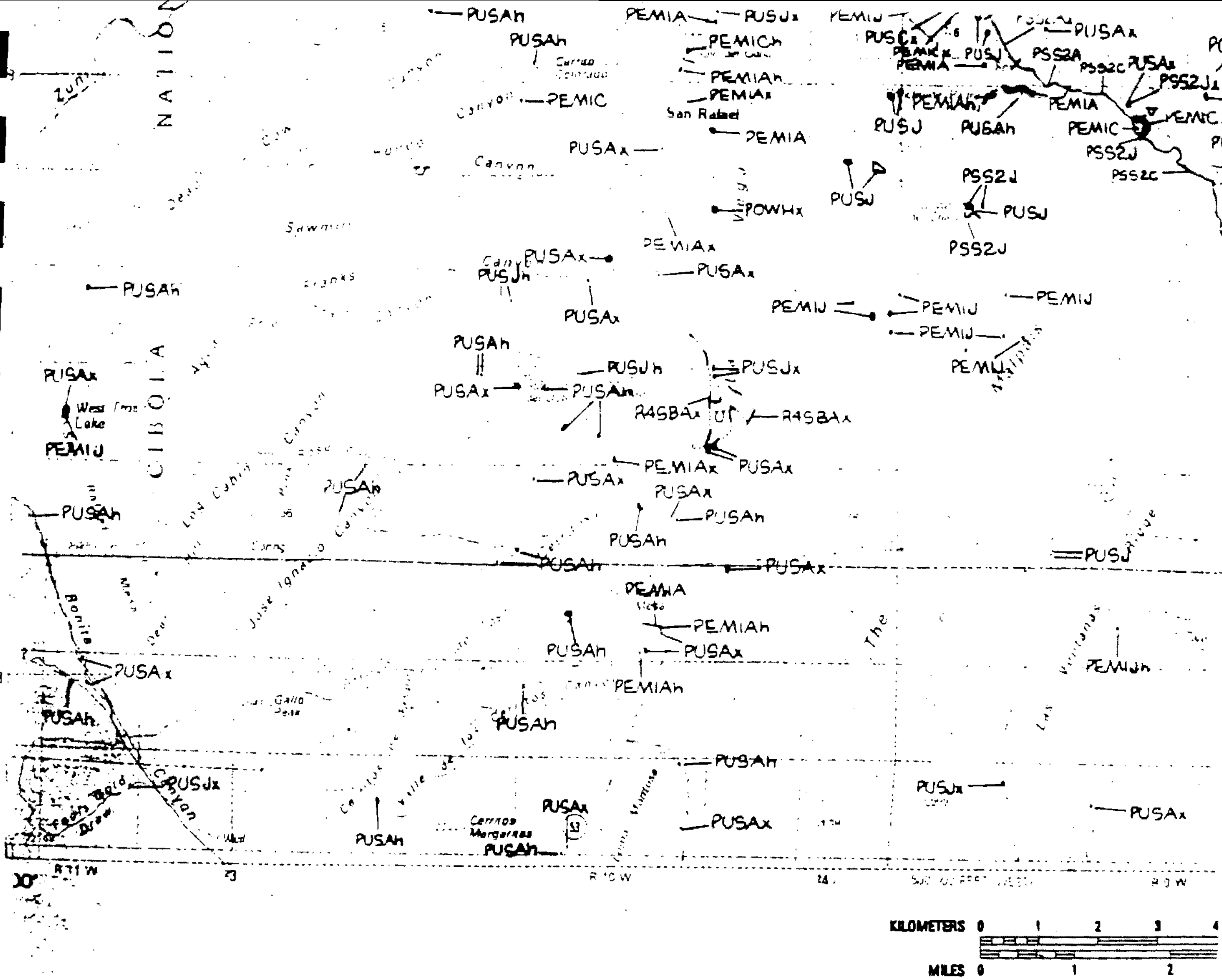
pH Modifiers for all Fresh Water
a Acid
t Circumneutral
i Alkaline

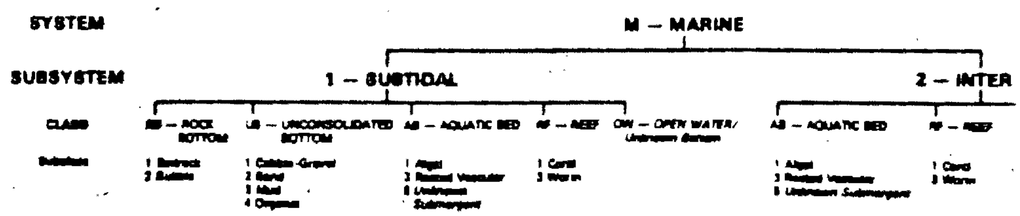
SOIL

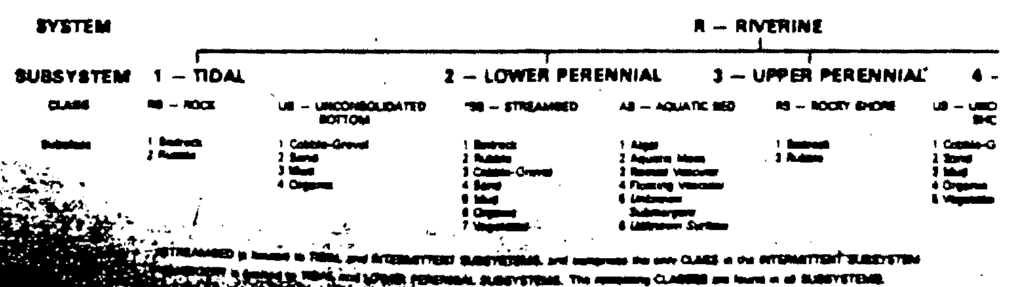
g Organic
n Mineral

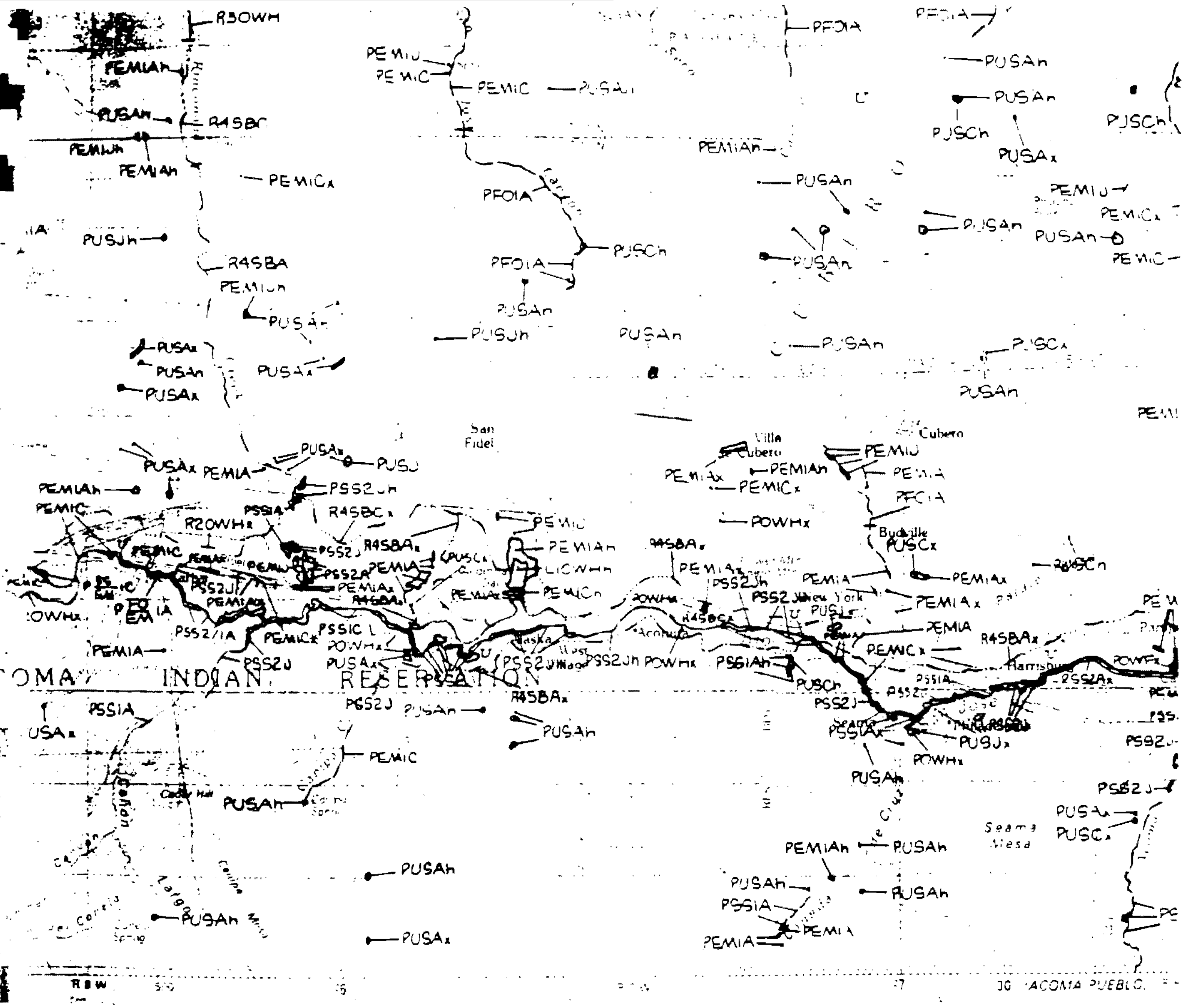
SPEC[IAL]

b Beaver
d Partially Drained/Ditched
f Farmed


PUSAh
PEMIA
PUSJx
PEMICh
PEMIAh
PEMIAx
PEMIC
San Rafael
PUSAx
PSS2A
PSS2C
PSS2J
PUSJ
POWHx
PUSJh
PEMIJ
R4SBAx
CIBOLA
NATION
West Lake
Bonito
Canyon
R 11 W
R 10 W
KILOMETERS 0 1 2 3 4
MILES 0 1 2

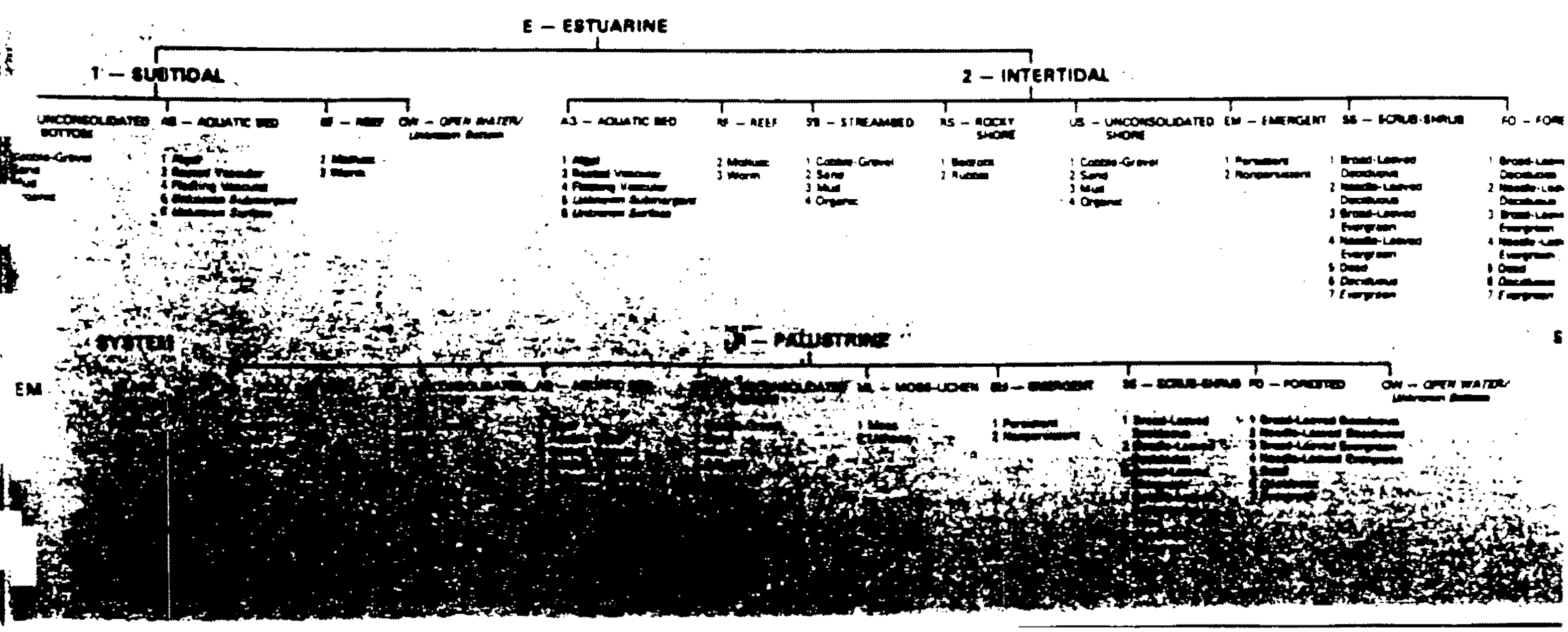

SYSTEM
M — MARINE
SUBSYSTEM
1 — SUBTIDAL
2 — INTER


SYSTEM
R — RIVERINE
SUBSYSTEM
1 — TIDAL
2 — LOWER PERENNIAL
3 — UPPER PERENNIAL



SCALE 1:100 000

1 CENTIMETER ON THE MAP REPRESENTS 1 KILOMETER ON THE GROUND



REFERENCE # 10

NAVAJO SUPERFUND OFFICE

BROWN VANDEVER URAN-
IUM MINE REFERENCE
MATERIAL

MAY, '90 P. MOLLOY

Uranium Geology and Exploration

Richard H. De Voto

Colorado School of Mines
Golden, Colorado

URANIUM GEOLOGY
AND EXPLORATION

BY

RICHARD H. DE VOTO

LECTURE NOTES AND REFERENCES

COLORADO SCHOOL OF MINES
GOLDEN, COLORADO 80401

MARCH, 1978

GEOCHEMISTRY OF URANIUM

I. Atomic Chemistry of Uranium

A. Atomic Number: 92, heaviest naturally occurring element.

B. Atomic Weight: 238.03

C. Naturally Occurring Isotopes

Mass No.	Abundance Wt. %	Activity % (radioactive decay events per unit of time)
238	99.28	48.9
235	0.71	2.2
234	0.0054	48.9

D. Nuclear Properties

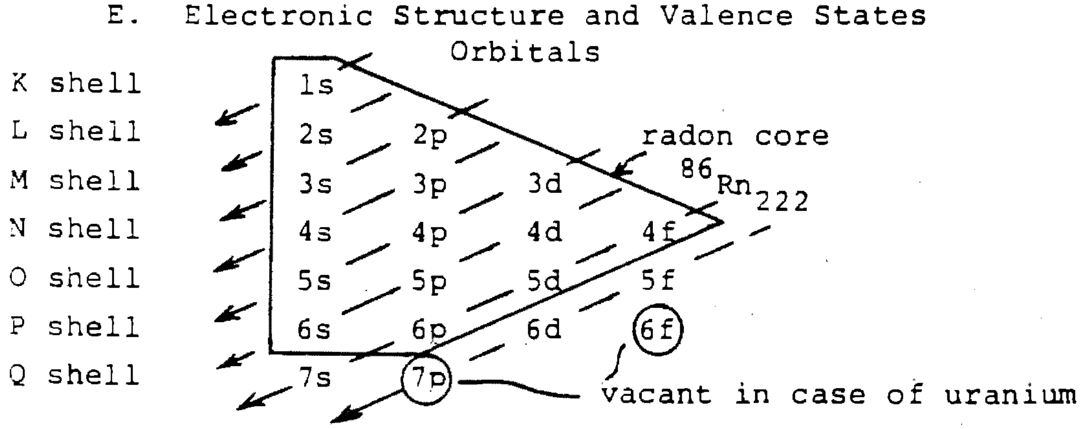
1. All isotopes of uranium are radioactive.

2. U-235 is readily fissionable.

3. All isotopes of all elements above Bismuth (83) are radioactive.

Isotope	Half Life
U^{238}	4.51×10^{9} years
U^{235}	7.1×10^{8} years
U^{234}	2.48×10^{5} years

E. Electronic Structure and Valence States



2. Energy of decay process often results in oxidation, therefore U^{234} may be U^{+6} from U^{238} in UO_2 (uraninite) Note: U^{238} and U^{235} always in fixed ratio in nature.

VI. Measurement of Nuclear Radiation

A. Alpha (α) radiation measured by

1. proportional counters (gross α radioactivity)

2. semiconductor detectors, for α energy spectrometry

3. photographic techniques (track etch) radon α particularly

4. helium analysis with mass spectrometer

B. Beta (β) radiation

1. measured with proportional counter

2. not very useful, except for ore grade control

C. Gamma (γ) radiation

1. Because of high range and discrete energy levels, most frequently measured radiation

2. Geiger counter

a. inexpensive, measures total γs from all sources, non energy selective

b. γs enter gas-filled tube, ionize gas, giving electrical impulse

3. Scintillation counter

a. medium resolution γ energy spectra

b. medium cost $2000 - 20,000

c. γ strikes NaI crystal, converts energy to light. Sorts light intensity for different energies

4. Semiconductor detector (germanium)

   a. high resolution γ spectra

   b. high cost

D. Uranium Analysis by Gamma Spectrometry

1. U^{238} series

   a. U^{238}, U^{235}, U^{234} γ energies are too low for practical measurement

   b. Bi^{214}, daughter in U^{238} series, has γ energies of 0.61 MeV and 1.76 MeV which are readily measured. Figure 28.

   c. Bi^{214} is good measure of Rn^{222}

   d. Bi^{214} activity is reliable measure of U^{238}-U^{235} activity <u>only</u> if sample has not weathered for 1 million years, and radon has not escaped for 3 weeks

   e. Bi^{214} is the mechanism of "radiometric assaying" for uranium

2. Th^{232} series

   a. Tl^{208} daughter has high energy 2.615 MeV γ (Figure 29)

   b. Th^{232} analysis by measuring Tl^{208} activity because short-lived daughters

   c. Some Th^{232} series γs interfere with 1.76 MeV γ from Bi^{214}, so need to know Th content when measure Bi^{214} activity

3. K^{40} gamma spectrum

   a. high energy 1.46 MeV γ (Figure 30)

4. Superimpose U^{238}, Th^{232}, and K^{40} γ spectra

   a. 2.615 MeV, Tl^{208} from Th^{232}

   b. 1.76 MeV, Bi^{214} from U^{238}

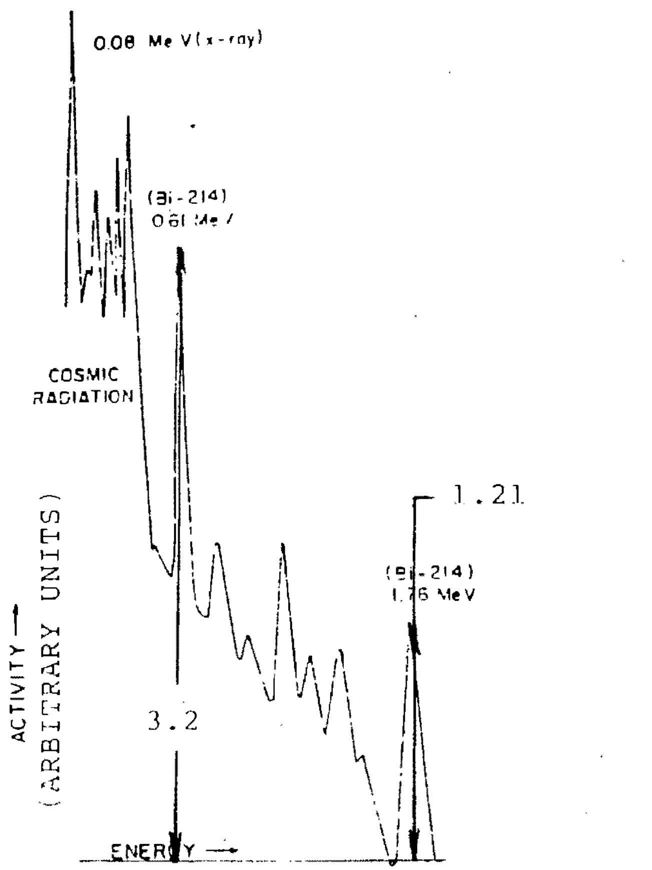


Fig. 28. Gamma spectrum of equilibrium U-238 ,U-235 series.

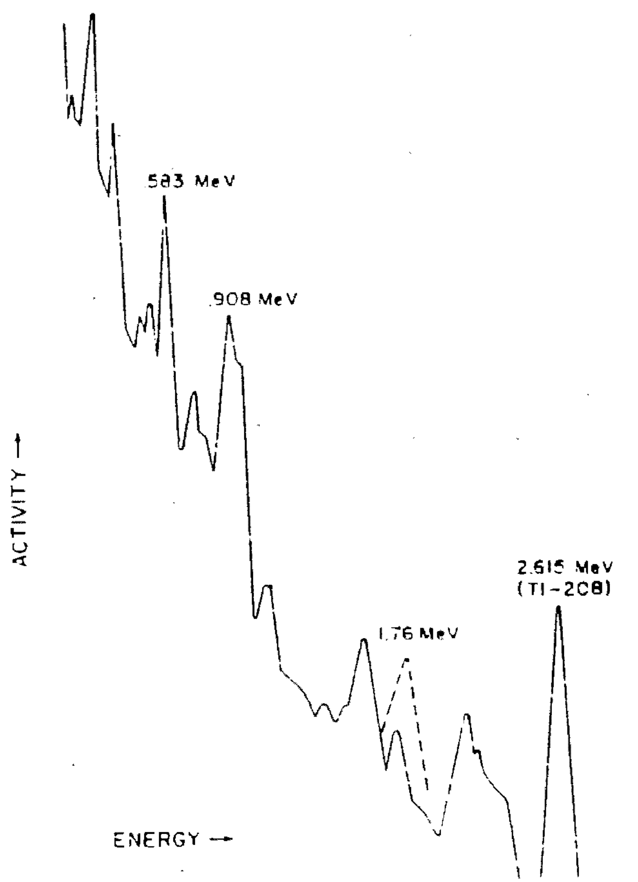


Fig. 29. Gamma spectrum of equilibrium Th-232 series.

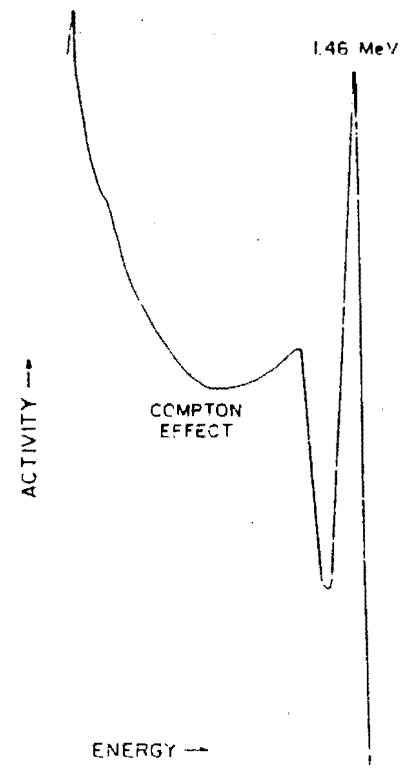


Fig. 30. K-40 gamma spectrum.

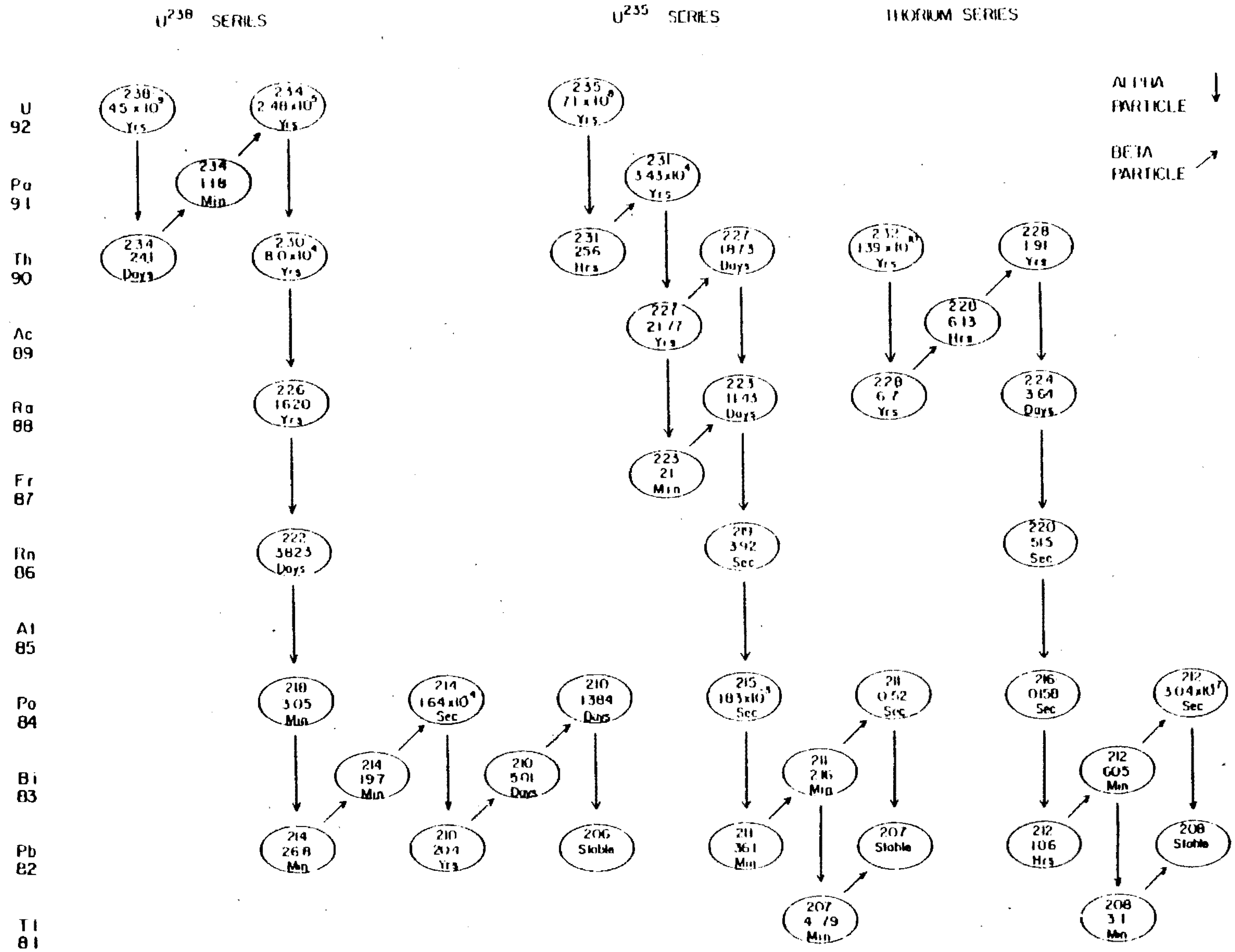


Fig. 27. U^{238}, U^{235}, and Th^{232} natural radioactivity decay series, particles emitted, and half lives. (Friedlander, Kennedy, and Miller, 1964)

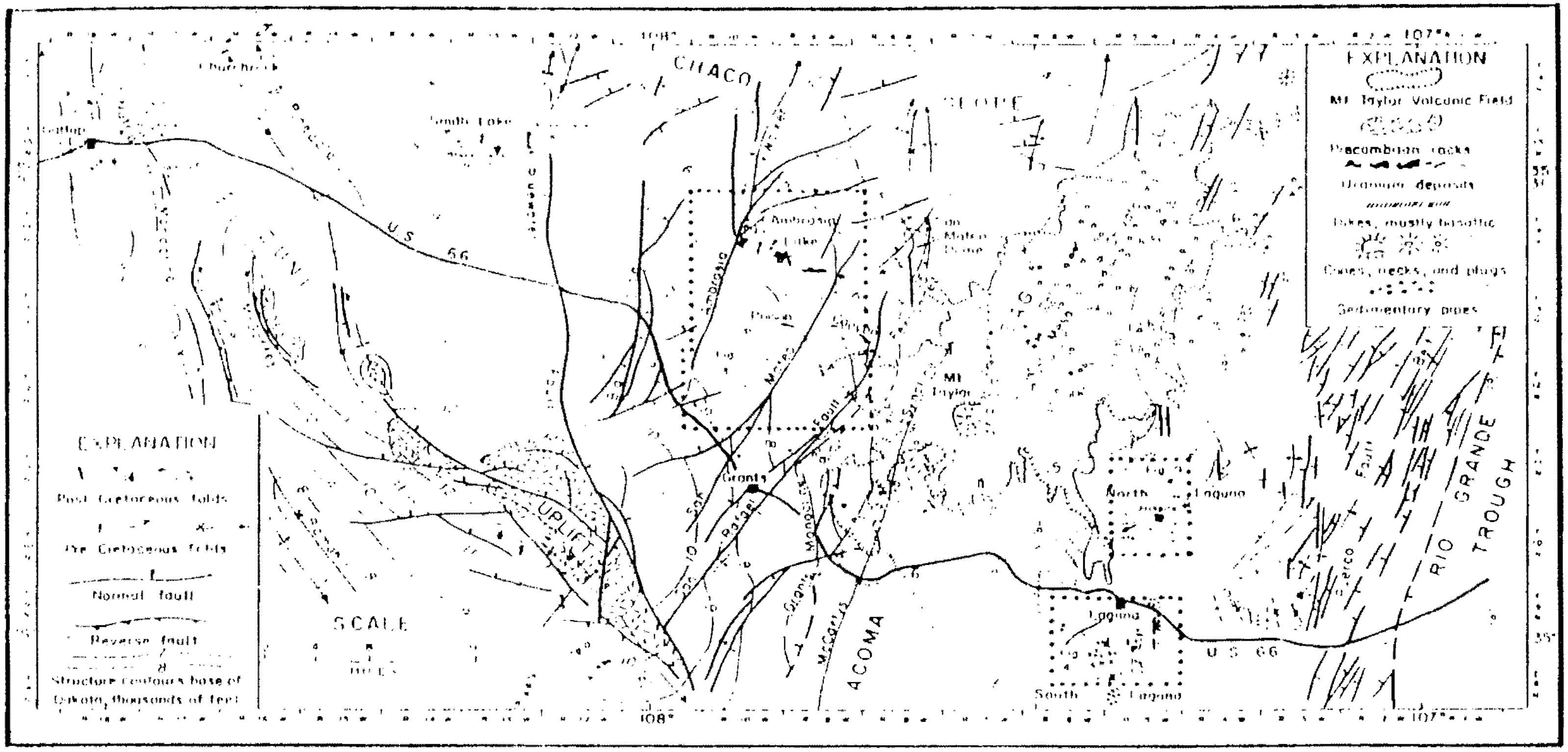


Fig. 126. *Geologic features of the Grants Region.* (Kelley, and others, 1968)

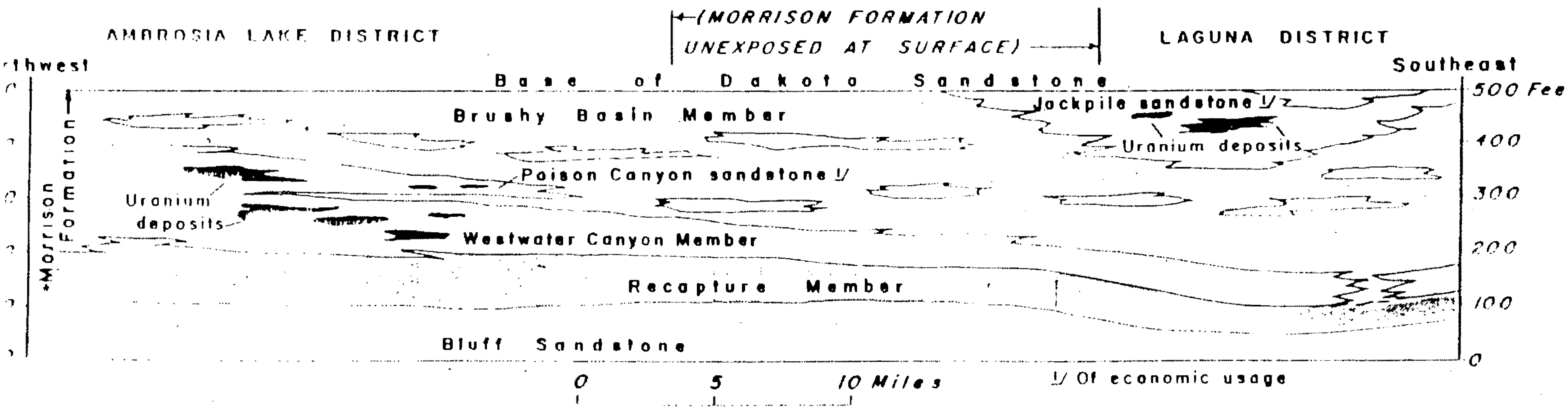


Figure 127

Generalized geologic section showing the stratigraphic relations of the Morrison Formation between Ambrosia Lake and Laguna

(Hilpert, 1963)

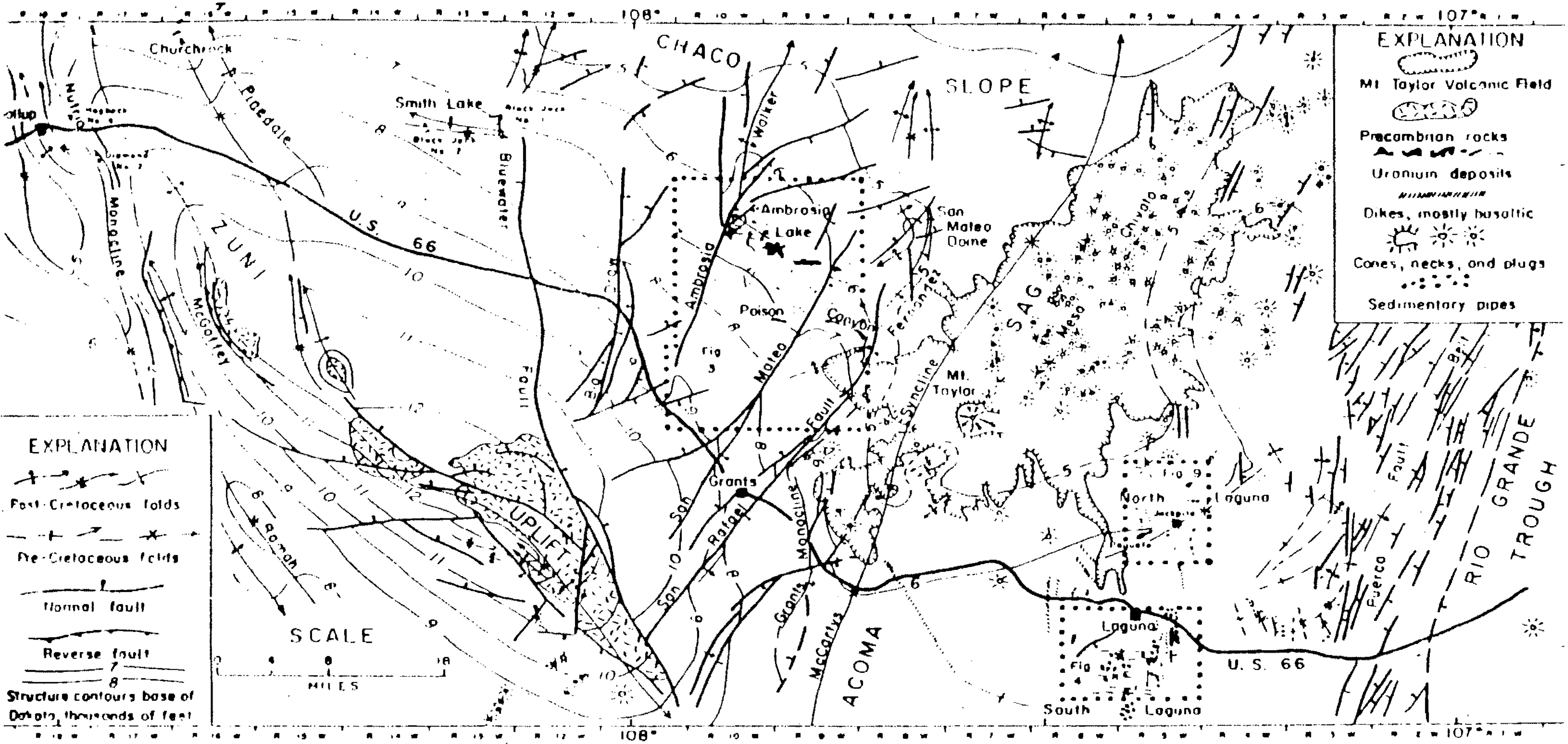
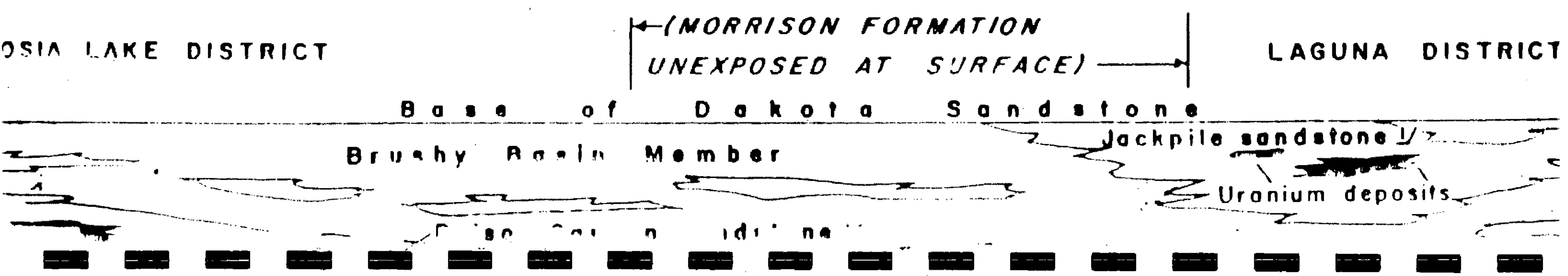


Fig. 126. *Geologic features of the Grants Region.* (Kelley, and others, 1968)



F. Organic-rich limestones (epigenetic)

1. Dynamic ground water system

2. Ocean water (2ppb U) or oxidizing uraniferous ground water by evaporitic pumping (Fig. 139)

3. Todilto U deposits, Grants, New Mexico

a. Algal stromatolites, organic rich

b. Rest on red, hematitic Entrada Sandstone

c. U probably derived from Fe-Mg silicates in Entrada

d. Evaporitic pumping of uraniferous ground water to organic-rich reducing environment in Todilto

G. Coals (epigenetic)

1. Uranium accumulation principally in low-rank coals

2. Beneath unconformity with overlying tuffaceous oxidized rocks

3. Black Hills example (Fig. 140)

H. Sulfide-bearing veins (epigenetic)

1. Beneath an unconformity (Fig. 141), or

2. at the ground surface

I. Reducing gas moving to uraniferous oxidizing water

1. H_2S, methane, or other volatile hydrocarbons move upward, through ground water

a. U and pyrite precipitation at ground water table (Fig. 31r)

b. U and pyrite precipitation at positions of maximum reduction, at or near point of introduction of reductant into oxidizing ground waters (Fig. 142):

1. along faults (S. Texas, NW Colorado)

2. above subcrop positions of petroliferous aquifers

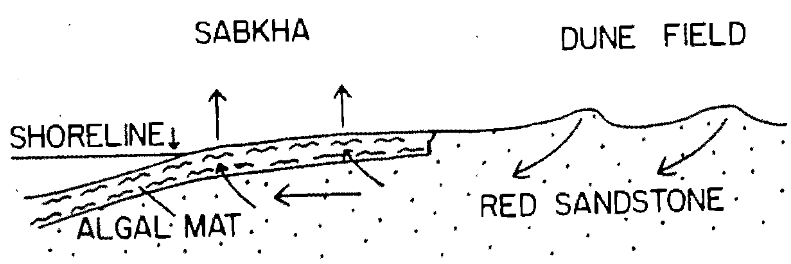


Fig. 139 Evaporitic pumping bringing oxidizing uraniferous ground water through underlying sandstone (Entrada) into reducing environment of algal stromatolitic limestones (Todilto Limestone).

REFERENCE # 11

NAVAJO SUPERFUND OFFICE

BROWN VANDEVER URANIUM MINE REFERENCE MATERIAL

MAY, '90 P. [illegible]

Uranium Resources of Northwestern New Mexico

GEOLOGICAL SURVEY PROFESSIONAL PAPER 603

Prepared on behalf of the U.S. Atomic Energy Commission

Uranium Resources of Northwestern New Mexico

By LOWELL S. HILPERT

GEOLOGICAL SURVEY PROFESSIONAL PAPER 603

Prepared on behalf of the
U.S. Atomic Energy Commission

A description of the stratigraphic and structural relations of the various types of uranium deposits in one of the world's great uranium-producing regions

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1969

TABLE 4.—*Uranium deposits, by county, in northwestern New Mexico*—Continued

Name of deposit	Location Sec.	T.	R.	Description of deposit and sample	Source of data
				McKinley County—Continued	
Junior (*4*)	NE¼ 4	13 N.	10 W.	Mineralized zone in carbonaceous sandstone near base of Dakota Sandstone. Ore mined from opencut, 1953.	FN, November 19[illegible]
Pat (Dakota) (*62*)	SE¼NE¼ 4 about 300 ft from ¼ cor. secs. 3 and 4.	13 N.	10 W.	Several lenses of dark-gray radioactive material in zone about 15 ft thick in upper part of 60- to 80-ft-thick sandstone. This sandstone may be at base of Jmb or at top of Jmw. The lenses are in buff to gray crossbedded sandstone and range in thickness from a few inches to about 1 ft. In 1954, the workings were four short partly connected adits, all within an outcrop distance of about 100 ft. Mined in 1952–63 but most of ore mined since 1958.	Do.
Section 5 (Westvaco; Febco(?)) (*6*).	5	13 N.	10 W.	Probably in Dakota Sandstone, but some may occur in Jmb. Ore was mined from adit, 1958.	AEC.
Sections 10 and 11	10 and 11	13 N.	10 W.	Mineralized material in sandstone in Jmb and possibly in Jmw.	AEC, DH.
Sections 12 and 13	12 and 13	13 N.	10 W.	Mineralized material in sandstone in Jmb and possibly in Jmw. Locality is near western limit of Jmpc. Relations of the deposits to Jmpc are not known.	Do.
Section 14	NE¼ 14	13 N.	10 W.	Some mineralized sandstone and a few scattered mineralized fossil logs at outcrop, probably in Jmpc.	Mathewson (1953, p. 11).
Red Point Lode (*28*).	SW¼SW¼ NW¼ 16.	13 N.	10 W.	Small deposit in middle and lower parts of Todilto Limestone, associated with eastward-trending intraformational anticlinal fold in limestone. Deposit mined from open pit, 1952–55.	Gabelman (1956b, p. 394); McLaughlin 1963, p. 146).
Section 17	NW¼ 17	13 N.	10 W.	Several small deposits in Todilto Limestone	Food Machinery and Chemical Corp., DH, July 1955; and AEC, DH.
Do	NW¼NW¼ SW¼ 17.	13 N.	10 W.	Small deposit in Todilto Limestone	Do.
Section 18, NE¼	S½NE¼ 18	13 N.	10 W.	Northward extension of several medium deposits from SE¼ of section and several other scattered small deposits in Todilto Limestone.	AEC, DH.
Section 18, SW¼ (Williams and Thompson) (*32*).	SW¼ 18	13 N.	10 W.	Cluster of medium and small irregularly shaped deposits in Todilto Limestone. Several deposits mined from inclined shaft, others from opencuts, 1952–64.	Federal Uranium Corp., DH, June 1956; AEC
Section 18, SE¼ (Williams) (*33*).	SE¼ 18	13 N.	10 W.	Cluster of medium and small irregularly shaped deposits in Todilto Limestone. Deposits mined from open pits, 1953.	AEC, DH.
Haystack (Haystack Butte; Section 19, NW¼) (*16*).	NW¼ 19	13 N.	10 W.	Large, irregularly shaped, roughly tabular, partly oxidized deposit approximately in middle part of Todilto Limestone. Deposit is elongate northward and associated with numerous intraformational folds in limestone, some of which include the top few feet of the Entrada Sandstone These folds have diverse trends, but the dominant trends are northward and eastward. Ore mined from opencut, 1952–57.	FN, July 1955; Haystack Mountain and Development Co., DH, 1955; Gabelman 1956b, p. 393–396).
Section 19, NE¼ (*34*).	N½N½NE¼ 19	13 N.	10 W.	Several small or medium deposits, near or at outcrop of Todilto Limestone. Deposits mined in 1959–64.	AEC.
Section 22, NE¼	NE¼ 22	13 N.	10 W.	Small deposit in Todilto Limestone. Deposit worked by open pit, but no shipments reported.	McLaughlin (1963, p. 146).
Section 23 (*38*)	S½SE¼ 23	13 N.	10 W.	Cluster of small and medium irregularly shaped deposits in middle and lower parts of Todilto Limestone. Cluster is in elongate zone about 300 ft wide that trends eastward along southern margin of SE¼ of section and into adjoining secs. 25 and 26. Ore mined from opencuts, 1957–58.	Haystack Mountain and Development Co., DH, June 1[illegible] and January 19[illegible]
Bob Cat (*11*)	NE¼NE¼(?) 24	13 N.	10 W.	Deposit probably in Jmpc. Ore shipped in 1955	AEC.

The high uranium content of the host rock is demonstrated by a suite of 10 samples collected between Abiquiu and Santa Fe (fig. 18). Uranium content of these samples ranged from 2 to 12 ppm (parts per million) and averaged >5 ppm. Eight of the samples were sandstone and two were siltstone. Although they were collected roughly parallel to the strike of the beds, they likely represent several hundred feet of stratigraphic section, including the part that contains the uranium deposits, because the coverage is about 40 miles.

The high uranium content of the Tesuque Formation can most likely be attributed to the high uranium concentrations in the volcanic ash, as shown by the following five samples:

Sample	Locality	Description	Uranium content (ppm) U	Uranium content (ppm) eU [1]
2A [2]	Center E½ sec. 33, T. 19 N., R. 9 E. (≈1 mile south of locality of sample 252605, fig. 18).	Top 3 in. of 42-in.-thick exposure of ash bed.	18.1	(3)
2B [2]	do	28 in. above base of ash bed described for sample 2A.	10.7	(3)
2 [2]	do	6 in. above base of ash bed described for sample 2A.	5.6	(3)
239584	NW¼SE¼ sec. 17, T. 20 N., R. 9 E.	Channel across 4-ft-thick white tuff bed.	(3)	20
239585	Center SW¼ sec. 17, T. 20 N., R. 9 E. (≈3,500 ft northeast of locality of sample 252603, fig. 18, and 1,700 ft west of locality of sample 239584 (see above).	do	(3)	30

[1] Analyst, C. O. Angelo.
[2] Data from R. L. Cannon (oral commun., 1965).
[3] No data.

These samples show a range in content of 5.6–30 ppm U or eU and, although the eU values may be high because of disequilibrium, the tuffs probably average more than the entire host rock.

The uranium deposits postdate the Tesuque Formation. Their surficial relations and envelopment within radioactive opal, which also coats surficial debris, indicate that they were probably formed in the present cycle of weathering.

PENECONCORDANT DEPOSITS IN TODILTO LIMESTONE AND ADJACENT FORMATIONS

About 100 deposits or clusters of deposits are listed in the Todilto Limestone, of Jurassic age, on plate 1. Deposits occur in other limestone units, but are uncommon; nearly all of them are associated with faults and are classified as vein deposits. A few others are segments of deposits that are primarily in sandstone; they have been described previously. Most of the deposits in the Todilto Limestone are in the Ambrosia Lake and Laguna districts, McKinley and Valencia Counties. A few are scattered in the southern part of the Chama Basin, Rio Arriba County, and in the Chuska district, San Juan County.

From 1950 to 1964, about 980,000 tons of ore was produced from 52 mines in the Todilto Limestone. This ore had an average grade of 0.22 percent U_3O_8 but ranged from 0.10 to 0.43 percent U_3O_8 among the mines. Prior to 1959, 445,000 tons of this ore averaged 0.14 percent V_2O_5 and had a U : V ratio of about 5 : 2, similar to that of most of the deposits in sandstone. All but a few thousand tons was mined in the Ambrosia Lake District; the remainder came from three mines in the Laguna district and one mine in Rio Arriba County.

The ores ranged fro 25 to 98 percent lime and averaged 80 percent. Ores from only a few mines averaged less than 50 percent $CaCO_3$; these were mostly mixed ores that came from deposits that extended into the underlying Entrada Sandstone or overlying Summerville Formation, such as the Sandy, Zia, and Haystack 2.

STRATIGRAPHY

Regional stratigraphy of the Todilto Limestone and its relations to the underlying Entrada Sandstone and overlying Summerville Formation were outlined previously (p. 18), but the local stratigraphy in the Ambrosia Lake and Laguna districts will be discussed in more detail to explain the relationships of the deposits.

In the Ambrosia Lake district only the limestone member crops out, but the gypsum-anhydrite member has been penetrated by drill holes about 8 miles north of the outcrop (J. C. Wright, written commun., 1957). The limestone member, which contains all the deposits, ranges in thickness from about 5 to 30 feet and averages about 15 feet. It comprises three units which are referred to locally as the basal "platy," medial "crinkly," and the upper "massive" zones. The platy and crinkly zones are about equal in thickness and compose about half the total thickness of the member. They consist of fine-grained laminated and thin-bedded limestone, which contains thin siltstone partings and locally seams of gypsum. Black fine-grained films of carbon-rich material are conspicuous locally, especially along the partings in the crinkly unit. Bedding in the platy unit is undisturbed, but in the crinkly unit is intensely crenulated. The massive unit is more coarsely crystalline and indistinctly bedded limestone, and it varies markedly in thickness from place to place.

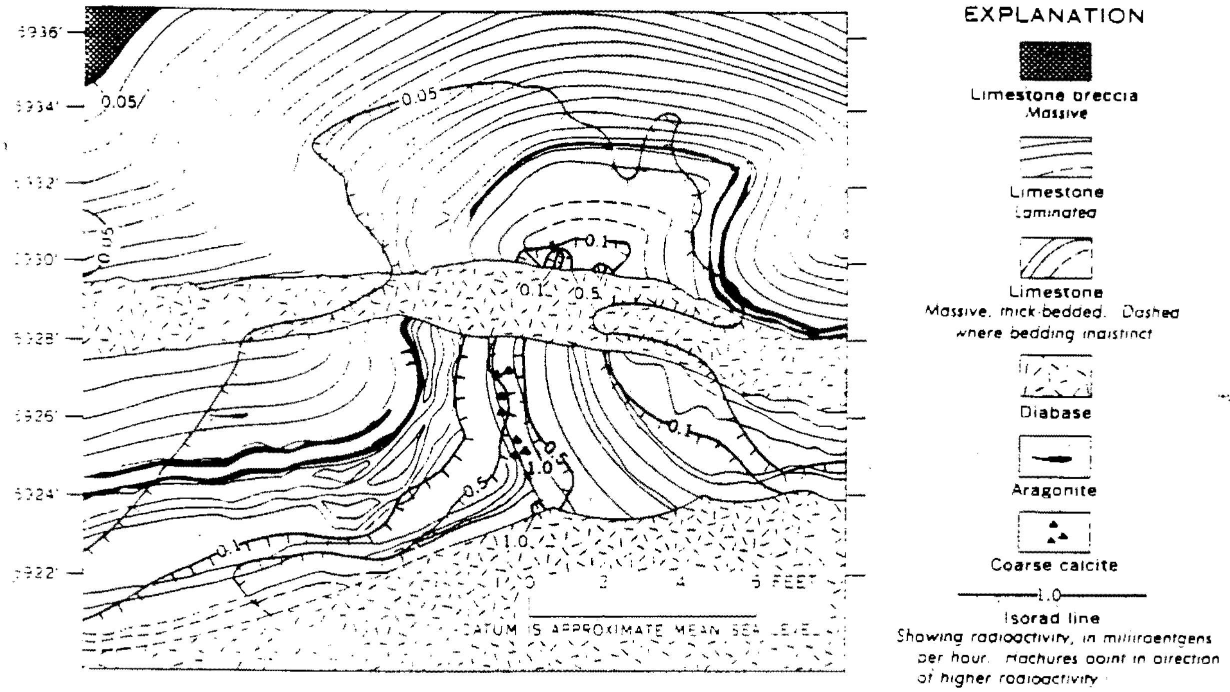


FIGURE 19.—Geologic section across uranium deposit in Todilto Limestone, showing displacement by diabase intrusive, Sandy mine area. Geology by Frank Hensley.

intersect deposits, the deposits are displaced and therefore must be older.

Gabelman (1956b, p. 391–392, fig. 132), however, implied that the deposits may be younger than the faults and folds by noting that the deposits occur within the area of strongest faulting and along the axes of northeastward-trending folds, both of which are on the flank of the Zuni uplift and within the sharpest bend of the strike of the Thoreau homocline (meaning the bend of the Chaco slope southeastward around the Zuni uplift and southward along the west flank of the McCartys syncline).

Gabelman's northeastward-trending folds probably are related to the subparallel faults (see p. 61), and both probably are the same age. Because the faults displace the deposits, both the folds and the faults must be younger than the deposits and could not have influenced their emplacement.

The oldest recognizable structural features that are certainly younger than the deposits are the fractures in the Laguna district that formed contemporaneously with the Rio Grande trough during the third period of deformation. These fractures are intruded by diabasic dikes and sills which, in turn, are broken by the same set of fractures, a relation that indicates their contemporaneity. The deposits show no relation to the fractures, and the diabasic intrusives displace and metamorphose the uranium deposits (Moench, 1962; 1963c, p. 161) (fig. 19). These facts demonstrate that the deposits are clearly older than the fractures and the intrusives.

Field relations indicate the fractures and intrusives probably formed mostly in middle to late Tertiary time, and probably prior to the Mount Taylor eruptions. Inclusions of the diabase were found in a volcanic pipe that probably supplied one of the earliest basaltic flows (Hilpert and Moench, 1960, p. ~~111~~). The fact that these flows were extruded during the latest stages of the Mount Taylor eruptions indicates the diabasic rocks are at least older than what may be the oldest basaltic flows. Because the entire sequence of Mount Taylor probably formed during an eruptive cycle, a relatively short period of time, the diabasic intrusions probably took place before the Mount Taylor cycle, as well as before the basaltic extrusions. Conclusions are that the deposits are older than any of the intrusive igneous rocks within the Laguna and Ambrosia Lake districts and that their emplacement could not have been influenced by them.

PENECONCORDANT DEPOSITS IN SHALE AND COAL

Deposits in shale and coal are quite similar in mineralogy and form to those in sandstone and, in some instances, where they occur in nearly equal proportions in both rock types, are classified rather arbitrarily. The host rocks, however, are different, so the deposits are separated for descriptive purposes. The deposits occur in shale and coal of Permian, Cretaceous, and Tertiary

Rapaport, Hadfield, and Olson (1952) first described the intraformational folds and dated their development as shortly after deposition of the Todilto sediments. Gabelman (1956b) described some of them in detail and drew similar conclusions regarding the age of their formation, and Hilpert and Moench (1960) described their association and probable contemporaneity with the larger pre-Dakota folds in the Ambrosia Lake and Laguna districts.

The intraformational folds occur in a great variety of shapes, ranging from open and closed anticlines to recumbent folds, chevron folds, and fan folds. They are mostly anticlinal and asymmetric, but some are synclinal, open, and symmetrical. Most of the folds are small, pronounced structural features that have amplitudes generally less than their breadths. The largest have a breadth of as much as 50 feet and an amplitude of about 25 feet and involve the entire thickness of the Todilto and basal part of the overlying Summerville Formation. The smallest are measured in inches or fractions of an inch and commonly bear a drag relation to larger folds. In length the folds range from a few feet to hundreds of feet. They mostly are somewhat sinuous and elongate, but some are rather tortuous in plan or are simply domal.

The folds generally tend to be concentrated or clustered, and in both the Ambrosia Lake and Laguna districts the fold axes in the clusters generally trend eastward or northward. Others show an almost random arrangement.

All the folds are fractured or jointed and some are faulted. The associated faults, however, are almost invariably intraformational and die out within the folds or within the Todilto Limestone and basal part of the Summerville Formation. Many faults are reverse type and closely follow the axial plane of tight or recumbent folds. All the related faults, however, show little displacement, seldom more than a foot or so and generally not more than a few inches.

Most joints are nearly vertical and comprise many sets. The principal set is longitudinal to the folds and probably formed with the folds or shortly after, similar to the intraformational faults. Other subsidiary joints make up an almost random pattern, although in some deposits in the Ambrosia Lake district a minor set is roughly normal to the fold axes. Many of the joints probably formed during later periods of deformation. The complexity of the fold and fracture patterns is illustrated by the structures in the Haystack, Gay Eagle, and Black Hawk deposits (Gabelman, 1956b, figs. 135–137).

In the Laguna district the intraformational folds are localized along the flanks and troughs of broad eastward- and northward-trending pre-Dakota synclines, and the dominant trends of the axes of the intraformational folds are likewise eastward and northward (Moench, 1963c, p. 159). (See fig. 9, this report.)

The Todilto Limestone in the Laguna district is also somewhat thicker in the synclines than on the crests of the adjoining folds. This fact suggests that the intraformational folds formed by flowage down the limbs of the pre-Dakota folds. This flowage apparently occurred under cover in post-Todilto time because the intraformational folds are not truncated by bedding planes.

Similar relations are indicated in the Ambrosia Lake district. Where data are available, particularly where uranium deposits have been mined, the intraformational folds also tend to trend eastward and northward and to make up clusters with similar trends (Gabelman, 1956b, figs. 134–138; Hilpert and Moench, 1960, p. 460–461, fig. 18). The pre-Dakota folds in the overlying rocks likewise trend eastward; others might also trend northward, as in the Laguna district, but more detailed information is needed to determine this.

In the Chuska district small anticlinal intraformational folds occur along a 4-mile strip of outcrop west of Sanostee in the upper part of the Todilto. The largest folds have amplitudes of as much as 2 feet, a width of 3 feet, and a length of 15 feet. Where concentrated or most highly developed they are subparallel, but show no relation to Laramide structures (J. W. Blagbrough, D. A. Thieme, B. J. Archer, Jr., and R. W. Lott, written commun., 1959).

In the south part of the Chama Basin, similar intraformational folds have been noted in the Todilto Limestone at the outcrop south and east of Coyote. Some of these folds have amplitudes of as much as several feet and widths of as much as 25 or 30 feet, but their lengths and trends are not known.

Structural features that formed principally during the second period of deformation in the Ambrosia Lake district consist of the Chaco slope or homocline, west flank of the McCartys syncline, a set of fractures and folds that range in trend from northeast to north, and some domal and anticlinal structures. (See p. 61–62). In the Laguna district they consist of the east limb of the McCartys syncline, a north-trending faulted monocline, and a set of faults and fractures that were intruded in many places by diabasic dikes and sills. (See p. 72).

MINERALOGY AND FORM

Mineralogy of the uranium deposits in the Todilto Limestone has been partly described by Rapaport, Hadfield, and Olson, (1952, p. 9–12), Laverty and Gross (1956, p. 200), and Truesdell and Weeks (1960), and has been summarized by Granger (1963, p. 33–35) and by McLaughlin (1963, p. 140).

The deposits in the Todilto differ from the ones in sandstone principally in their relative sparseness of metallic sulfide minerals and in the occurrence of fluorite.

Unoxidized minerals that have been identified are uraninite, coffinite, paramontroseite, haggite, fluorite, pyrite, marcasite, and galena. Barite, specular hematite, vanadium clay, and recrystallized calcite are closely associated with these minerals and probably are also primary.

Uraninite is more abundant than coffinite and occurs as colloform coatings on grain boundaries, as veinlets in limestone, and as replacements of the limestone grains along bedding planes and along the walls of veinlets. Coffinite at least locally coats uraninite and fills shrinkage cracks in uraninite.

The formation of haggite, paramontroseite, and vanadium clay generally preceded that of uraninite. The haggite occurs as fine blades and fibers along grain boundaries and solution channels in limestone, and some as intergrowths with paramontroseite. The vanadium clay in some places forms irregular spherical aggregates.

Fluorite has been observed in several deposits and likely is a constituent of most of them. It generally is purple and occurs as a fine-grained replacement of the limestone along bedding surfaces, as veinlets, and locally as irregular replacements of limestone that form masses as much as 6 inches in diameter. The fluorite generally is closely associated with and in places is replaced by uraninite.

Pyrite, marcasite, and galena are the only sulfide minerals identified in the deposits in the Todilto. Pyrite occurs as an early mineral which is generally corroded and replaced by later minerals but is most abundant as a late mineral which fills solution cavities and fractures and which replaces detrital grains. Marcasite has been identified only as a late mineral. Galena occurs as fine-grained cubes deposited with and after uraninite and coffinite and as a replacement of early pyrite and haggite.

Coarse-grained calcite occurs along bedding planes, fractures, and solution cavities as a replacement of limestone or as recrystallized limestone in and near the uranimum deposits. The coarse-grained calcite is both earlier and later than most other minerals.

Fine-grained hematite occurs in most of the deposits and generally is associated with the uraniferous zones. Specular hematite has been noted with vanadium clay. Hematite also occurs as pseudomorphs after pyrite and as stains along fractures and bedding planes in oxidized zones.

Barite occurs in most deposits as a resinous yellow to clove-brown tabular mineral that lines solution cavities and forms veinlets or irregular globelike replacements of coarse-grained calcite or local disseminations along the bedding.

Most of the deposits in the Todilto occur at or near the surface and so have been subjected to oxidation which has led to the rather widespread occurrence of the conspicuous yellow and green secondary minerals tyuyamunite, metatyuyamunite, uranophane, and probably sklodowskite. Less common secondary minerals are carnotite, cuprosklodowskite, gummite, santafeite, liebigite, and various oxides of manganese and iron. Also, the dark-olive green fibrous vanadyl vanadate, grantsite, was identified in the F-33 mine (Weeks and others, 1961) and probably occurs in other deposits in the Todilto.

Early field-examination reports generally mentioned carnotite as a constituent of most deposits and created the impression that the mineral was one of the more common ones. Most of the reported occurrences, however, were probably tyuyamunite, which is more likely to form in limestone in which calcium is in excess of sodium. Tyuyamunite and carnotite are both canary yellow and difficult to distinguish in the field.

Uranium deposits in the Todilto are roughly tabular bodies having an irregular form similar to the forms of the deposits in sandstone. Most of them occur along the flanks of the folds and some along the fold axes roughly parallel to the bedding, but locally the deposits cut across the bedding. Many of them are near the base of the Todilto, but others are near the middle or top, and a few occupy the entire limestone interval. Many are not confined to the limestone, but extend a few inches and in some places several feet into the underlying Entrada Sandstone, and in many deposits as much as several feet into the overlying siltstone of ths Summerville Formation. A few deposits are mostly, or entirely, in the basal part of the Summerville or top of the Entrada Sandstone. Although these deposits have a relationship to bedding that is similar to that of deposits in other sandstones, they are dissimilar in their association with folds in the overlying or underlying Todilto Limestone.

Dimensions of the deposits in the Todilto range from a few feet in width and length to several hundred feet in width and more than 1,000 feet in length, and in thickness from mere seems to as much as 20 feet. They probably average a few tens of feet in width, a hundred feet or so in length, and about 10 feet in thickness.

The largest deposits occur where the folds in the limestone are clustered and have a similar trend. Because of the clustering, the deposits associated with individual folds interconnect or merge into relatively large masses that in some places are rather irregular or oblong, such as the Haystack (Gabelman, 1956b, figs. 133, 135) and Flat Top 4-Vilatie Hyde deposits. Others merge and interconnect to form stringlike masses having a length many times their width, such as the F-33 (Hilpert and Moench, 1960, fig. 18), the Faith (McLaughlin, 1963, fig. 6), and the Section 25. The dominant trends of these masses are eastward or northward, similar to the trends of the intraformational folds, but many are heterogeneous.

Ore bodies generally constitute the central parts of the deposits where the deposits are thicker and higher in grade. Away from ore, the deposits feather out or grade into barren host rock along rather irregular or vaguely defined zones. Ore bodies range from masses with dimensions of only a few feet that contain several tons of ore to masses that are hundreds of feet wide, more than 1,000 feet long, and several feet thick, and contain as much as 100,000 tons of ore. Most ore bodies, however, average about 25 feet in width, 100 feet in length, and 5–7 feet in thickness, and contain about 1,000 tons of ore. McLaughlin's (1963, fig. 6) map of the Faith deposit is a good example of the general relations of ore to mineralized ground.

Grade of the ore ranges from 0.10 U_3O_8 to at least 10.0 percent U_3O_8.

STRATIGRAPHIC RELATIONS OF THE DEPOSITS

Uranium deposits in the Todilto Limestone show no direct relation to the stratigraphy of the formation but possibly are indirectly related to the gypsum-anhydrite member and probably are indirectly related to the original thickness of the limestone member.

From place to place the deposits occur at the base, middle, top, or throughout the limestone member and, in many places, extend into the top of the underlying Entrada Sandstone or base of the overlying Summerville Formation. No known deposits occur in the gypsum-anhydrite member, but all the principal deposits are near its outcrop. (See pl. 3.) This position of the deposits in relation to the member probably stems from chance exposure, but for some unknown physical or chemical reason, the gypsum-anhydrite member may have influenced the emplacement of the deposits near its margin.

Near the principal deposits the limestone member is about 15–25 feet thick (pl. 3). Elsewhere it is generally less than 15 feet thick. This occurrence of deposits near thicker limestone may also be a result of fortuitous exposure—the Todilto Limestone has been explored at most only a few miles from the outcrop—but more probably it expresses some relation of the deposits to the original thickness of the limestone.

STRUCTURAL RELATIONS OF THE DEPOSITS

Primary uranium deposits in the Todilto were directly controlled by structures that resulted from the first period of deformation (Late Jurassic to Early Cretaceous), but show few effects, except secondary ones, from later deformation.

The deposits are closely related to intraformational folds in the limestone and these folds are related to broader open folds in the Jurassic rocks, which are dated as post-Todilto and pre-Dakota. The deposits are postsyngenetic because they cross the limestone bedding (fig. 19), and are postintraformational folding because they transect the intraformational folds (Gabelman, 1956b, fig. 136, cross section L–K) and at least locally transect the broader pre-Dakota folds (Hilpert and Moench, 1960, p. 458, fig. 15; Moench, 1963c, p. 163–164).

The original thickness of the limestone (see above) probably had a direct bearing on the localization and development of the intraformational folds. Confinement of the folds largely within the limestone indicates its relative incompetence; it should follow that where the limestone is thickest it would have a tendency to absorb a greater percentage of the stresses exerted on the rock column. Thus, the degree of deformation expressed by the folds would most likely be a direct result of the original thickness of the limestone member. The deposits are directly related to the folds and generally to their degree or intensity of development; thus they are indirectly related to the original thickness of the limestone.

No convincing evidence supports the possibility that localization of the primary deposits was influenced by the second (Late Cretaceous to middle Tertiary) or third (middle Tertiary to late Tertiary or Quaternary) periods of deformation. Present information indicates that the oldest structural features resulting from these periods of deformation are the faults and folds that formed contemporaneously with the development of the McCartys syncline. As indicated above, the syncline and the associated smaller features probably formed during development of the Zuni and Lucero uplifts and the Acoma sag, and probably prior to the northward tilting of the San Juan Basin (pre-San Jose, or pre-early Eocene time).

In the Ambrosia Lake district, deposits do not occupy fault zones except for the intraformational faults within the Todilto Limestone. Where faults

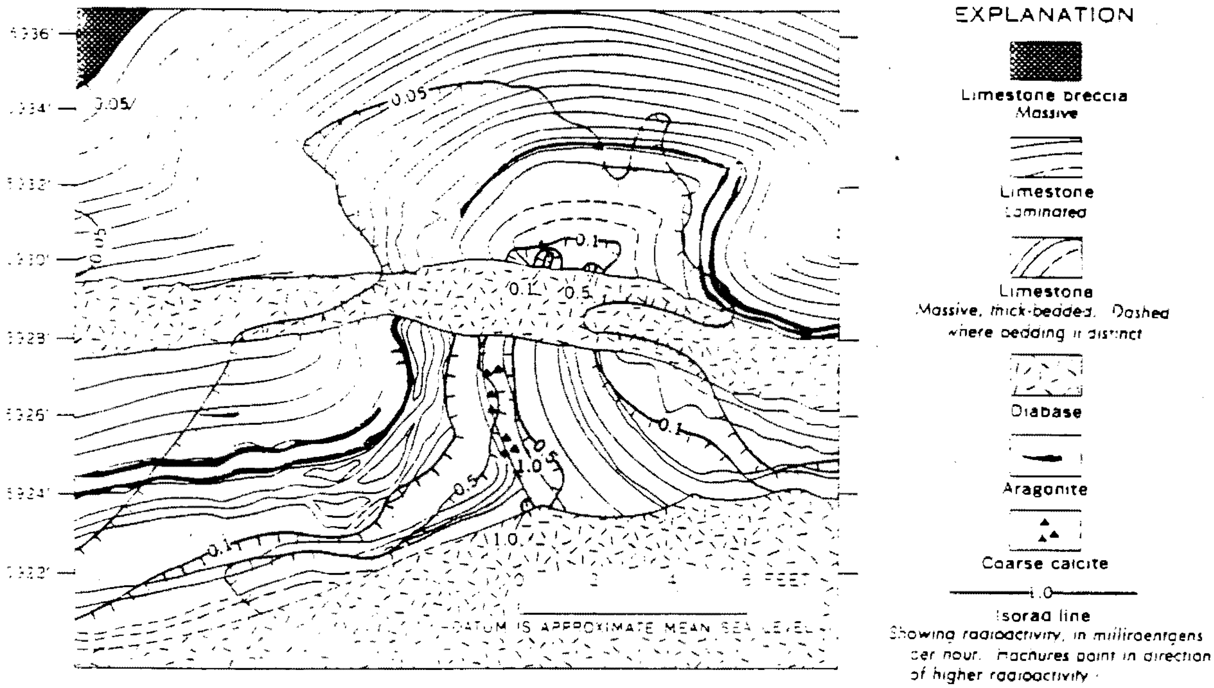


FIGURE 19.—Geologic section across uranium deposit in Todilto Limestone, showing displacement by diabase intrusive, Sandy mine area. Geology by Frank Hensley.

intersect deposits, the deposits are displaced and therefore must be older.

Gabelman (1956b, p. 391–392, fig. 132), however, implied that the deposits may be younger than the faults and folds by noting that the deposits occur within the area of strongest faulting and along the axes of northeastward-trending folds, both of which are on the flank of the Zuni uplift and within the sharpest bend of the strike of the Thoreau homocline (meaning the bend of the Chaco slope southeastward around the Zuni uplift and southward along the west flank of the McCartys syncline).

Gabelman's northeastward-trending folds probably are related to the subparallel faults (see p. 61), and both probably are the same age. Because the faults displace the deposits, both the folds and the faults must be younger than the deposits and could not have influenced their emplacement.

The oldest recognizable structural features that are certainly younger than the deposits are the fractures in the Laguna district that formed contemporaneously with the Rio Grande trough during the third period of deformation. These fractures are intruded by diabasic dikes and sills which, in turn, are broken by the same set of fractures, a relation that indicates their contemporaneity. The deposits show no relation to the fractures, and the diabasic intrusives displace and metamorphose the uranium deposits (Moench, 1962; 1963c, p. 161) (fig. 19). These facts demonstrate that the deposits are clearly older than the fractures and the intrusives.

Field relations indicate the fractures and intrusives probably formed mostly in middle to late Tertiary time, and probably prior to the Mount Taylor eruptions. Inclusions of the diabase were found in a volcanic pipe that probably supplied one of the earliest basaltic flows (Hilpert and Moench, 1960, p. ~~144~~). The fact that these flows were extruded during the latest stages of the Mount Taylor eruptions indicates the diabasic rocks are at least older than what may be the oldest basaltic flows. Because the entire sequence of Mount Taylor probably formed during an eruptive cycle, a relatively short period of time, the diabasic intrusions probably took place before the Mount Taylor cycle, as well as before the basaltic extrusions. Conclusions are that the deposits are older than any of the intrusive igneous rocks within the Laguna and Ambrosia Lake districts and that their emplacement could not have been influenced by them.

PENECONCORDANT DEPOSITS IN SHALE AND COAL

Deposits in shale and coal are quite similar in mineralogy and form to those in sandstone and, in some instances, where they occur in nearly equal proportions in both rock types, are classified rather arbitrarily. The host rocks, however, are different, so the deposits are separated for descriptive purposes. The deposits occur in shale and coal of Permian, Cretaceous, and Tertiary

TABLE 6.—*Semiquantitative spectrographic, radiometric, and chemical analyses of mill pulp samples of uranium ores from limestone, northwestern New Mexico*

[Material within brackets is descriptive, not part of mine name. Italic numbers are mine numbers shown on plate 1. Spectrographic determinations are semiquantitative and were made by the rapid visual comparison method. Comparisons of similar data with those obtained by quantitative methods show that the assigned semiquantitative class interval includes the quantitative value in about 60 percent of the determinations. Figures are reported to the nearest number in the series >10, 7, 3, 1.5, 0.7, 0.3, 0.15, and are coded as follows: >10=1, 7=2, 3=3, 1.5=4, 0.7=5, 0.3=6, 0.15=7, 0.07=8, 0.03=9, 0.015=10, 0.007=11, 0.003=12, 0.0015=13, 0.0007=14, 0.0003=15. Figures reported as less than (<) are coded: <1.0=a, <0.05=b, <0.02=c, <0.005=d, <0.002=e, <0.001=f, <0.0005=g, <0.0002=h, <0.00005=i. 0, looked for but not found; <, less than amount shown, standard detectability does not apply; Tr., trace; leaders (....), not looked for; number enclosed in parentheses is near threshold of detectability; ND, no data

[Spectrographic analyses are in percent, coded; other analyses are in percent or parts per million, as indicated, and are not coded]

Sample[1]	Name of mine or prospect	Spectrographic[2]																
		Ag	Al	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Dy	Er
	Ore in the Todilto Limestone																	
56424	Barbara J 1 (*1*)	0	3	0	0	0	9	0	0	1	0	b	14	13	....	12	0	0
56425	Billy The Kid (*3*)	0	4	0	0	0	9	0	0	1	0	b	15	14	....	12	0	0
56426	Black Hawk (*4*)	0	4	0	0	0	9	0	0	1	0	b	14	14	....	12	0	0
56427	Bunney (*4*)	0	4	0	0	0	9	0	0	1	0	b	14	14	....	12	0	0
29390	Cedar 1 (*5*)	i	5	0	0	b	9	0	0	1	0	b	(15)	12	ND	13	0	0
56428	Christmas Day (*6*)	0	5	0	0	0	9	0	0	1	0	b	14	14	....	13	0	0
45228	Crackpot (*7*)	0	4	0	0	0	10	0	0	1	0	....	0	13	....	12	0	0
56429	Flat Top 4 (*12*)	0	3	0	0	0	9	0	0	1	0	b	15	13	....	13	0	0
56430	Gay Eagle (*13*)	0	4	0	0	0	9	0	0	1	0	b	15	14	....	13	0	0
29393	Hanosh (Section 26) (*16*)	i	4	0	0	b	9	0	0	1	0	b	(15)	13	ND	13	0	0
56431	Haystack 2 (*17*)	0	3	0	0	0	8	0	0	1	0	b	15	13	....	13	0	0
56432	Last Chance (*19*)	0	4	0	0	0	8	0	0	1	0	b	14	14	....	12	0	0
56433	Red Bluff 3 (*24*)	0	5	0	0	0	9	0	0	1	0	b	14	15	....	13	0	0
56434	Red Bluff 5 (*25*)	0	4	0	0	0	8	0	0	1	0	b	14	14	....	13	0	0
56435	Red Bluff 7 (*26*)	0	4	0	0	0	9	0	0	1	0	b	15	14	....	12	0	0
56436	Red Bluff 8 (*13*)	0	3	0	0	0	8	0	0	1	0	b	14	13	....	12	0	0
29391	Red Bluff 10 (*13*)	i	4	0	0	b	9	0	0	1	0	b	(15)	14	ND	13	0	0
56437	Red Point Lode (*28*)	0	5	0	0	0	8	0	0	1	0	b	15	14	....	13	0	0
46891	Reed Henderson	0	5	0	0	0	9	0	0	1	0	....	0	13	....	13	0	0
56438	Rimrock (*29*)	0	5	0	0	0	9	0	0	1	0	b	15	14	....	12	0	0
56439	Section 18 (*32*)	Tr.	3	0	0	0	7	0	0	1	0	b	14	13	....	12	0	0
56440	Section 18 (*33*)	0	3	0	0	0	8	0	0	1	0	b	15	13	....	12	0	0
29395	Section 19 (*34*)	1	5	0	0	b	11	0	0	1	12	b	g	15	ND	13	0	0
56441	Section 21 (*37*)	0	2	0	0	0	9	0	0	1	0	b	15	14	....	12	0	0
56442	Section 24 (*39*)	0	3	0	0	0	8	0	0	1	0	b	15	14	....	12	0	0
29392	Manol (Section 30) (*22*)	i	4	0	0	b	10	0	0	1	0	b	(15)	12	ND	13	0	0
56443	Manol (Section 30, T-8) (*22*)	0	4	0	0	0	9	0	0	1	0	b	15	13	....	12	0	0
56444	Manol (Section 30, T-19) (*22*)	0	3	0	0	0	9	0	0	1	0	b	14	13	....	12	0	0
29394	T 2 (*45*)	1	5	0	0	b	10	0	0	1	(12)	b	g	14	ND	13	0	0
56445	Tom Elkins (*48*)	0	2	0	0	0	7	0	0	1	0	b	15	14	....	12	0	0
56446	UDC 5 (*49*)	0	4	0	0	0	9	0	0	1	0	b	14	14	....	12	0	0
	Ore in the Todilto Limestone and Entrada Sandstone																	
[illegible]	Sandy (*76*)	0	3	0	0	Tr.	9	0	0	1	0	0	13	12	....	12	0	0

ELEM	Al	Ba	Ca	Co	Cr	Cu	Fe	K	Mg	Mn	Mo	Na	Ni	Pb	Si	Sr	Ti	U	V	Zr	As	F	Se	Zn	
			T					I				T?												I?	
	NT		NT	DD		NT	NT	NT				NT		?	NT									NT	
CODE	3	8	1	15	13	13	5	3	6	8	13	5	15	11	1	10	8	7	9	10					
PPM		100			15				3000	700	15			70		150	700	1500	300	150	8	60	8	10	PPM

1:
2:
5:
6: .3% → 3000
7: .15% → 1500
8: .07% = 700
9: .03% = 300
10: .015% = 150
11: .007% = 70
13: .0015% = 15
15:

NT - NOT TOXIC
T - TRACE
DD - DOWN IN THE DIRT

TABLE 6.—*Semiquantitative spectrographic, radiometric, and chemical analyses of mill pulp samples of uranium ores from limestone, northwestern New Mexico*

[Material within brackets is descriptive, not part of mine name. Italic numbers are mine numbers shown on plate 1. Spectrographic determinations are semiquantitative and were made by the rapid visual comparison method. Comparisons of similar data with those obtained by quantitative methods show that the assigned semiquantitative class interval includes the quantitative value in about 60 percent of the determinations. Figures are reported to the nearest number in the series >10, 7, 3, 1.5, 0.7, 0.3, 0.15, and are coded as follows: >10=1, 7=2, 3=3, 1.5=4, 0.7=5, 0.3=6, 0.15=7, 0.07=8, 0.03=9, 0.015=10, 0.007=11, 0.003=12, 0.0015=13, 0.0007=14, 0.0003=15. Figures reported as less than (<) are coded: <1.0=a, <0.05=b, <0.02=c, <0.005=d, <0.002=e, <0.001=f, <0.0005=g, <0.0002=h, <0.00005=i. 0, looked for but not found; <, less than amount shown, standard detectability does not apply; Tr., trace; leaders (......), not looked for; number enclosed in parentheses is near threshold of detectability; ND, no data

Spectrographic analyses are in percent, coded; other analyses are in percent or parts per million, as indicated, and are not coded]

Sample [1]	Name of mine or prospect	Spectrographic [2]																
		Ag	Al	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Dy	Er
	Ore in the Todilto Limestone																	
256424	Barbara J 1 (*1*)	0	3	0	0	0	9	0	0	1	0	b	14	13	......	12	0	0
256425	Billy The Kid (*3*)	0	4	0	0	0	9	0	0	1	0	b	15	14	......	12	0	0
256426	Black Hawk (*4*)	0	4	0	0	0	9	0	0	1	0	b	14	14	......	12	0	0
256427	Bunney (*4*)	0	4	0	0	0	9	0	0	1	0	b	14	14	......	12	0	0
229390	Cedar 1 (*5*)	i	5	0	0	b	9	0	0	1	0	b	(15)	12	ND	13	0	0
256428	Christmas Day (*6*)	0	5	0	0	0	9	0	0	1	0	b	14	14	......	13	0	0
245228	Crackpot (*7*)	0	4	0	0	0	10	0	0	1	0	......	0	13	......	12	0	0
256429	Flat Top 4 (*12*)	0	3	0	0	0	9	0	0	1	0	b	15	13	......	13	0	0
256430	Gay Eagle (*13*)	0	4	0	0	0	9	0	0	1	0	b	15	14	......	13	0	0
229393	Hanosh (Section 26) (*15*)	i	4	0	0	b	9	0	0	1	0	b	(15)	13	ND	13	0	0
256431	Haystack 2 (*17*)	0	3	0	0	0	8	0	0	1	0	b	15	13	......	13	0	0
256432	Last Chance (*19*)	0	4	0	0	0	8	0	0	1	0	b	14	14	......	12	0	0
256433	Red Bluff 3 (*24*)	0	5	0	0	0	9	0	0	1	0	b	14	15	......	13	0	0
256434	Red Bluff 5 (*25*)	0	4	0	0	0	8	0	0	1	0	b	14	14	......	13	0	0
256435	Red Bluff 7 (*26*)	0	4	0	0	0	9	0	0	1	0	b	15	14	......	12	0	0
256436	Red Bluff 8 (*13*)	0	3	0	0	0	8	0	0	1	0	b	14	13	......	12	0	0
229391	Red Bluff 10 (*13*)	i	4	0	0	b	9	0	0	1	0	b	(15)	14	ND	13	0	0
256437	Red Point Lode (*28*)	0	5	0	0	0	8	0	0	1	0	b	15	14	......	13	0	0
246891	Reed Henderson	0	5	0	0	0	9	0	0	1	0	......	0	13	......	13	0	0
256438	Rimrock (*29*)	0	5	0	0	0	9	0	0	1	0	b	15	14	......	12	0	0
256439	Section 18 (*32*)	Tr.	3	0	0	0	7	0	0	1	0	b	14	13	......	12	0	0
256440	Section 18 (*33*)	0	3	0	0	0	8	0	0	1	0	b	15	13	......	12	0	0
229395	Section 19 (*34*)	i	5	0	0	b	11	0	0	1	12	b	g	15	ND	13	0	0
256441	Section 21 (*37*)	0	2	0	0	0	9	0	0	1	0	b	15	14	......	12	0	0
256442	Section 24 (*39*)	0	3	0	0	0	8	0	0	1	0	b	15	14	......	12	0	0
229392	Manol (Section 30) (*22*)	i	4	0	0	b	10	0	0	1	0	b	(15)	12	ND	13	0	0
256443	Manol (Section 30, T-8) (*22*)	0	4	0	0	0	9	0	0	1	0	b	15	13	......	12	0	0
256444	Manol (Section 30, T-19) (*22*)	0	3	0	0	0	9	0	0	1	0	b	14	13	......	12	0	0
229394	T 2 (*45*)	i	5	0	0	b	10	0	0	1	(12)	b	g	14	ND	13	0	0
256445	Tom Elkins (*48*)	0	2	0	0	0	7	0	0	1	0	b	15	14	......	12	0	0
256448	UDC 5 (*49*)	0	4	0	0	0	9	0	0	1	0	b	14	14	......	12	0	0
	Ore in the Todilto Limestone and Entrada Sandstone																	
245229	Sandy (*7F*)	0	3	0	0	Tr.	9	0	0	1	0	0	13	12	......	12	0	0
	Ore in the San Andres Limestone																	
245227	Lucky Don (*1*)	0	4	0	0	Tr.	11	0	0	1	0	0	13	12	......	12	0	0
	Ore in the Madera Limestone																	
254110	Agua Torres (*1*)	0	3	0	0	12	7	0	0	3	0	0	14	12	......	11	0	0
254109	Marie (*2*)	14	3	5	0	12	8	0	0	2	0	0	12	11	......	9	0	0

See footnotes at end of table.

TABLE 6.—*Semiquantitative spectrographic, radiometric, and chemical analyses of mill pulp samples of uranium ores from limestone, northwestern New Mexico*—Continued

Sample [1]	Name of mine or prospect	Spectrographic [2]—Continued																
		Eu	F	Fe	Ga	Gd	Ge	Hf	Hg	Ho	In	Ir	K	La	Li	Lu	Mg	Mn
	Ore in the Todilto Limestone																	
256424	Barbara J 1 (*1*)	0	......	6	0	0	0	0	0	0	0	0	4	0	0	0	6	8
256425	Billy The Kid (*3*)	0	......	6	0	0	0	0	0	0	0	0	0	0	0	0	6	8
256426	Black Hawk (*4*)	0	......	5	0	0	0	0	0	0	0	0	0	0	0	0	6	8
256427	Bunney (*4*)	0	......	6	0	0	0	0	0	0	0	0	5	0	0	0	6	8
229390	Cedar 1 (*5*)	ND	ND	5	h	0	0	0	0	ND	0	0	a	0	0	ND	6	9
256428	Christmas Day (*6*)	0	......	6	0	0	0	0	0	0	0	0	0	0	0	0	6	8
245228	Crackpot (*7*)			6	0	0	0	0	0	......	0	0	4	0	0	......	6	9
256429	Fiat Top 4 (*12*)	0	......	6	0	0	0	0	0	0	0	0	5	0	0	0	6	[illegible]
256430	Gay Eagle (*13*)	0	......	6	[illegible]	0	0	0	0	0	0	0	[illegible]	0	0	0	6	8
229393	Hanosh (Section 26) (*16*)	ND	ND	6	h	0	0	0	0	ND	0	0	(5)	0	0	ND	6	8
256431	Haystack 2 (*17*)	0	......	5	0	0	0	0	0	0	0	0	3	0	0	0	6	8
256432	Last Chance (*19*)	0	......	6	0	0	0	0	0	0	0	0	5	0	0	0	6	7
256433	Red Bluff 3 (*24*)	0	......	5	0	0	0	0	0	0	0	0	0	0	0	0	7	7
256434	Red Bluff 5 (*25*)	0	......	6	0	0	0	0	0	0	0	0	0	0	0	0	6	7
256435	Red Bluff 7 (*25*)	0	......	6	0	0	0	0	0	0	0	0	0	0	0	0	6	8
256436	Red Bluff 8 (*13*)	0	......	5	0	0	0	0	0	0	0	0	5	0	0	0	6	[illegible]
229391	Red Bluff 10 (*13*)	ND	ND	6	h	0	0	0	0	ND	0	0	a	0	0	ND	6	8
256437	Red Point Lode (*28*)	0	......	6	0	0	0	0	0	0	0	0	0	0	0	0	7	[illegible]
246891	Reed Henderson			7	0	0	0	0	0	......	0	0	4	0	0	......	5	[illegible]
256438	Rimrock (*29*)	0	......	6	0	0	0	0	0	0	0	0	0	0	0	0	6	[illegible]
256439	Section 18 (*32*)	0	......	6	0	0	0	0	0	0	0	0	4	0	0	0	6	[illegible]
256440	Section 18 (*33*)	0	......	5	0	0	0	0	0	0	0	0	3	0	0	0	5	[illegible]
229395	Section 19 (*34*)	ND	ND	7	h	0	0	0	0	ND	0	0	(5)	0	0	ND	6	[illegible]
256441	Section 21 (*37*)	0	......	6	0	0	0	0	0	0	0	0	0	0	0	0	6	[illegible]
256442	Section 24 (*39*)	0	......	6	0	0	0	0	0	0	0	0	4	0	0	0	6	[illegible]
229392	Manol (Section 30) (*22*)	ND	ND	6	h	0	0	0	0	ND	0	0	(5)	0	0	ND	6	[illegible]
256443	Manol (Section 30, T-8) (*22*)	0	......	6	0	0	0	0	0	0	0	0	5	0	0	0	6	
256444	Manol (Section 30, T-19) (*22*)	0	......	6	0	0	0	0	0	0	0	0	4	0	0	0	6	
229394	T 2 (*45*)	ND	ND	6	h	0	0	0	0	ND	0	0	a	0	0	ND	6	
256445	Tom Elkins (*48*)	0	......	6	0	0	0	0	0	0	0	0	0	0	0	0	6	
256446	UDC 5 (*49*)	0	......	6	0	0	0	0	0	0	0	0	0	0	0	0	6	
	Ore in the Todilto Limestone and Entrada Sandstone																	
245229	Sandy (*76*)			5	Tr.	0	0	0	0	......	0	0	3	0	0	......	5	
	Ore in the San Andres Limestone																	
245227	Lucky Don (*1*)			5	0	0	0	0	0	......	0	0	4	0	0	......	2	
	Ore in the Madera Limestone																	
254110	Agua Torres (*1*)	0	......	4	Tr.	0	0	0	0	0	0	0	4	0	0	0	5	
254109	Marie (*2*)	0	......	2	14	0	0	0	0	0	0	0	3	0	0	0	6	

See footnotes at end of table.

TABLE 6.—*Semiquantitative spectrographic, radiometric, and chemical analyses of mill pulp samples of uranium ores from limestone, northwestern New Mexico*—Continued

Sample [1]	Name of mine or prospect	Spectrographic [1]—Continued																
		Mo	Na	Nb	Nd	Ni	Os	P	Pb	Pd	Pr	Pt	Rb	Re	Rh	Ru	Sb	Sc
						Ore in the Todilto Limestone												
56424	Barbara J 1 (1)	13	5	0	0	13	0	0	11	0	0	0	......	0	0	0	0	0
56425	Billy The Kid (2)	0	6	0	0	14	0	0	12	0	0	0	......	0	0	0	0	0
56426	Black Hawk (3)	14	6	0	0	14	0	0	11	0	0	0	......	0	0	0	0	0
56427	Bunney (4)	14	6	0	0	14	0	0	12	0	0	0	......	0	0	0	0	0
29390	Cedar 1 (5)	14	6	0	0	14	0	0	11	0	ND	0	ND	0	0	0	0	f
56428	Christmas Day (6)	14	6	0	0	14	0	0	11	0	0	0	......	0	0	0	0	0
45228	Crackpot (7)	0	6	0	0	14	0	0	12	0	......	0	......	0	0	0	0	0
56429	Flat Top 4 (12)	0	6	0	0	14	0	0	11	0	0	0	......	0	0	[illegible]	0	0
56430	Gay Eagle (13)	14	6	0	0	15	0	0	11	0	0	0	......	0	0	0	0	0
29393	Hanosh (Section 26) (15)	12	6	0	0	14	0	0	10	0	ND	0	ND	0	0	0	0	f
56431	Haystack 2 (17)	13	5	0	0	15	0	0	11	0	0	0	......	0	0	0	0	0
56432	Last Chance (19)	0	6	0	0	14	0	0	11	0	0	0	......	0	0	0	0	0
256433	Red Bluff 3 (24)	13	6	0	0	14	0	0	11	0	0	0	......	0	0	0	0	0
56434	Red Bluff 5 (25)	12	6	0	0	14	0	0	11	0	0	0	......	0	0	0	0	0
56435	Red Bluff 7 (26)	0	6	0	0	14	0	0	11	0	0	0	......	0	0	0	0	0
56436	Red Bluff 8 (13)	14	6	0	0	13	0	0	11	0	0	0	......	0	0	0	0	0
29391	Red Bluff 10 (13)	13	6	0	0	14	0	0	11	0	ND	0	ND	0	0	0	0	f
56437	Red Point Lode (28)	0	6	0	0	15	0	0	12	0	0	0	......	0	0	0	0	0
46891	Reed Henderson	0	6	0	0	14	0	0	14	0	......	0	......	0	0	0	0	0
56438	Rimrock (29)	0	6	0	0	14	0	0	13	0	0	0	......	0	0	0	0	0
56439	Section 18 (32)	0	6	0	0	14	0	0	11	0	0	0	......	0	0	0	0	0
56440	Section 18 (33)	0	5	0	0	14	0	0	12	0	0	0	......	0	0	0	0	0
29395	Section 19 (34)	f	7	0	0	15	0	0	13	0	ND	0	ND	0	0	0	0	f
56441	Section 21 (37)	0	6	0	0	15	0	0	13	0	0	0	......	0	0	0	0	0
56442	Section 24 (39)	0	6	0	0	15	0	0	11	0	0	0	......	0	0	0	0	0
29392	Manol (Section 30) (22)	f	6	0	0	14	0	0	11	0	ND	0	ND	0	0	0	0	f
56443	Manol (Section 30, T-8) (22)	0	6	0	0	13	0	0	11	0	0	0	......	0	0	0	0	0
56444	Manol (Section 30, T-19) (22)	14	6	0	0	13	0	0	10	0	0	0	......	0	0	0	0	0
29394	T 2 (45)	f	7	0	0	14	0	0	13	0	ND	0	ND	0	0	0	0	f
56445	Tom Elkins (48)	0	6	0	0	14	0	0	12	0	0	0	......	0	0	0	0	0
56446	UDC 5 (49)	13	6	0	0	14	0	0	11	0	0	0	......	0	0	0	0	0
						Ore in the Todilto Limestone and Entrada Sandstone												
45229	Sandy (76)	13	4	0	0	14	0	0	12	0	......	0	......	0	0	0	0	0
						Ore in the San Andres Limestone												
45227	Lucky Don (1)	13	6	0	0	11	0	0	11	0	......	0	......	0	0	0	0	0
						Ore in the Madera Limestone												
54110	Agua Torres (1)	12	7	0	0	12	0	0	12	0	0	0	......	0	0	0	0	14
54109	Marie (2)	10	6	0	0	12	0	0	5	0	0	0	......	0	0	0	10	14

See footnotes at end of table.

TABLE 6.—*Semiquantitative spectrographic, radiometric, and chemical analyses of mill pulp samples of uranium ores from limestone, northwestern New Mexico*—Continued

Sample[1]	Name of mine or prospect	Spectrographic[1]—Continued																	
		Si	Sn	Sr	Sm	Ta	Tb	Te	Th	Ti	Tl	Tm	U	V	W	Y	Yb	Zn	Zr
	Ore in the Todilto Limestone																		
256424	Barbara J 1 (*1*)	1	0	9	0	0	0	0	0	8	0	0	6	9	0	14	d	0	[illegible]
256425	Billy The Kid (*3*)	3	0	8	0	0	0	0	0	9	0	0	8	7	0	0	d	0	[illegible]
256426	Black Hawk (*2*)	2	0	9	0	0	0	0	0	8	0	0	7	9	0	Tr.	d	0	[illegible]
256427	Bunney (*4*)	2	0	9	0	0	0	0	0	8	0	0	8	5	0	0	d	0	[illegible]
229390	Cedar 1 (*5*)	3	0	10	0	0	ND	0	0	9	0	ND	6	9	0	0	b	0	[illegible]
256428	Christmas Day (*6*)	3	0	9	0	0	0	0	0	9	0	0	7	8	0	0	d	0	[illegible]
245228	Crackpot (*7*)	3	0	9	0	0	......	0	0	11	0	......	8	7	0	0	e	0	[illegible]
256429	Flat Top 4 (*12*)	2	0	9	0	0	0	0	0	8	0	0	7	8	0	0	d	0	[illegible]
256430	Gay Eagle (*13*)	3	0	9	0	0	0	0	0	9	0	0	7	8	0	0	d	0	[illegible]
229393	Hanosh (Section 26) (*15*)	7	0	10	0	0	ND	0	0	8	0	ND	6	8	0	14	f	0	[illegible]
256431	Haystack 2 (*17*)	1	0	10	0	0	0	0	0	8	0	0	7	9	0	0	d	0	10
256432	Last Chance (*19*)	2	0	9	0	0	0	0	0	9	0	0	7	7	0	0	d	0	[illegible]
256433	Reb Bluff 3 (*22*)	3	0	9	0	0	0	0	0	10	0	0	7	10	0	0	0	0	[illegible]
256434	Reb Bluff 5 (*25*)	2	0	8	0	0	0	0	0	9	0	0	7	9	0	0	0	0	[illegible]
256435	Red Bluff 7 (*26*)	2	0	9	0	0	0	0	0	9	0	0	7	8	0	0	d	0	[illegible]
256436	Red Bluff 8 (*13*)	1	0	8	0	0	0	0	0	8	0	0	7	7	0	0	d	0	[illegible]
229391	Red Bluff 10 (*13*)	3	0	10	0	0	ND	0	0	9	0	ND	7	8	0	0	f	0	[illegible]
256437	Red Point Lode (*28*)	3	0	9	0	0	0	0	0	8	0	0	8	8	0	0	d	0	[illegible]
246891	Reed Henderson	3	0	9	0	0	......	0	0	9	0	......	0	8	0	0	......	0	[illegible]
256438	Rimrock (*29*)	3	0	8	0	0	0	0	0	9	0	0	8	7	0	0	d	0	[illegible]
256439	Section 18 (*32*)	1	0	8	0	0	0	0	0	9	0	0	7	7	0	0	d	0	[illegible]
256440	Section 18 (*33*)	1	0	9	0	0	0	0	0	8	0	0	8	7	0	14	d	0	11
229395	Section 19 (*34*)	4	0	10	0	0	ND	0	0	10	0	ND	7	7	0	0	f	0	13
256441	Section 21 (*37*)	3	0	8	0	0	0	0	0	9	0	0	7	7	0	0	d	0	13
256442	Section 24 (*39*)	1	0	9	0	0	0	0	0	8	0	0	7	8	0	0	d	0	10
229392	Manol (Section 30) (*22*)	3	0	10	0	0	ND	0	0	9	0	ND	6	7	0	0	f	0	12
256443	Manol (Section 30, T-8) (*22*)	1	0	9	0	0	0	0	0	8	0	0	7	8	0	0	d	0	12
256444	Manol (Section 30, T-19) (*22*)	1	0	9	0	0	0	0	0	8	0	0	6	9	0	Tr.	d	0	11
229394	T 2 (*45*)	3	0	10	0	0	ND	0	0	10	0	ND	7	7	0	0	f	0	12
256445	Tom Elkins (*48*)	3	0	8	0	0	0	0	0	9	0	0	7	7	0	0	d	0	12
256446	UDC 5 (*49*)	2	0	9	0	0	0	0	0	8	0	0	7	8	0	0	d	0	12
	Ore in the Todilto Limestone and Entrada Sandstone																		
245229	Sandy (*76*)	1	0	10	0	0	......	0	0	8	0	......	8	9	0	13	15	0	11
	Ore in the San Andres Limestone																		
245227	Lucky Don (*1*)	1	0	11	0	0	......	0	0	8	0	......	7	7	0	0	e	7	11
	Ore in the Madera Limestone																		
254110	Agua Torres (*1*)	1	0	7	0	0	0	0	0	7	0	0	8	9	ND	13	15	9	11
254109	Marie (*2*)	1	0	9	0	0	0	0	0	6	10	0	7	9	ND	13	15	7	10

[1] See footnotes at end of table.

TABLE 6.—*Semiquantitative spectrographic, radiometric, and chemical analyses of mill pulp samples of uranium ores from limestone, northwestern New Mexico*—Continued

Sample [1]	Name of mine or prospect	Radiometric: eU [3]	Chemical: U [4]	V_2O_5 [5]	S [6]	P_2O_5 [7]	C [8] (organic)	As [9]	F [10]	Se [11]	Zn [12]
		Percent						Parts per million			
Ore in the Todilto Limestone											
256424	Barbara J 1 (*1*)	0.23	0.23	0.09	0.07	0.026	0.11	16	50	5	20
256425	Billy The Kid (*3*)	.09	.09	.30	.03	.003	.08	3	50	1	10
256426	Black Hawk (*4*)	.12	.12	.08	.04	.015	.07	23	340	3	10
256427	Bunney (*4*)	.08	.08	.11	.03	.003	.08	11	30	2	10
229390	Cedar 1 (*5*)	.21	.24	....	....	.024	....	60	290	5	20
256428	Christmas Day (*6*)	.16	.16	.13	.04	.003	.10	18	290	4	10
245228	Crackpot (*7*)	.07	.10	.33	.11	.011	....	18	160	3	7
256429	Flat Top 4 (*12*)	.19	.20	.13	.03	.003	.09	18	630	3	10
256430	Gay Eagle (*13*)	.16	.18	.15	.03	.003	.06	20	190	4	10
229393	Hanosh (Section 26) (*15*)	.31	.34	....	....	.031	....	50	1,700	5	20
256431	Haystack 2 (*17*)	.15	.16	.13	.08	.015	.14	8	60	8	10
256432	Last Chance (*19*)	.12	13	.23	.03	.003	.06	6	50	2	10
256433	Red Bluff 3 (*22*)	.17	.16	.05	.04	.015	.05	33	90	4	10
256434	Red Bluff 5 (*25*)	.16	.16	.05	.03	.018	.06	21	90	3	10
256435	Red Bluff 7 (*26*)	.13	.13	.09	.04	.003	.07	12	120	2	10
256436	Red Bluff 8 (*13*)	.13	.14	.14	.03	.003	.08	19	150	3	10
229391	Red Bluff 10 (*13*)	.17	.18	....	....	.017	....	60	440	5	10
256437	Red Point Lode (*23*)	.11	.11	.07	.03	.005	.06	20	30	3	10
246891	Reed Henderson	.03	.03	.12	.05	.015	.92	8	30	.5	4
256438	Rimrock (*29*)	.10	.11	.28	.03	.003	.06	8	110	3	10
256439	Section 18 (*32*)	.15	.16	.33	.03	.003	.06	9	20	5	20
256440	Section 18 (*33*)	.10	.10	.23	.03	.003	.07	8	20	4	10
229395	Section 19 (*34*)	14	.14	....	....	.004	....	10	160	5	10
256441	Section 21 (*37*)	10	11	30	.03	.003	.06	2	20	2	10
256442	Section 24 (*39*)	19	.18	.15	03	.003	.06	2	20	1	30
229392	Manol (Section 30) (*22*)	.19	.23	....	....	.019	....	50	460	2	10
256443	Manol (Section 30, T-8) (*22*)	.17	.19	.11	.04	.007	.12	19	240	3	10
256444	Manol (Section 30, T-19) (*22*)	.28	31	.07	.04	.029	.10	16	130	3	10
229394	T 2 (*45*)	.12	.13	....	....	.004	....	10	130	1	20
256445	Tom Elkins (*48*)	12	.11	.19	.04	.003	.06	4	20	3	10
256446	UDC 5 (*49*)	.14	.14	.06	.04	.011	.06	29	370	5	10
Ore in the Todilto Limestone Limestone and Entrada Sandstone											
245229	Sandy (*76*)	0.09	0.10	0.13	0.08	0.024	....	15	60	15	12
Ore in the San Andres Limestone											
245227	Lucky Don (*1*)	0.17	0.22	0.43	0.06	0.011	....	41	240	10	330
Ore in the Madera Limestone											
254110	Agua Torres (*1*)	0.06	0.08	0.11	0.46	....	....	172	....	50	37
254109	Marie (*2*)	.17	.17	.05	3.27	....	....	6,200	390	75	2,100

[1] Spectrographic analyses, chemical analyses for As, Se, U, and Zn, and radiometric analyses for U for samples 229390–229395 inclusive requested by A. T. Miesch.
[2] Analysis of sample 246891 by N. M. Conklin; all others by R. G. Havens.
[3] Analysts: C. G. Angelo, R. P. Cox, G. S. Erickson, Mary Finch, W. D. Goss, H. H. Lipp, T. Miller, and J. S. Wahlberg.
[4] Analysts: C. G. Angelo, R. P. Cox, E. J. Fennelly, D. L. Ferguson, Mary Finch, W. D. Goss, H. H. Lipp, T. Miller and J. S. Wahlberg. Fluorimetric method.
[5] Analysts: W. D. Goss, H. H. Lipp, and J. S. Wahlberg. Volumetric method.
[6] Analysts: G. T. Burrow, D. L. Ferguson, and E. C. Mallory. Gravimetric method.
[7] Analysts: D. L. Ferguson and L. F. Rader, Jr. Volumetric method.
[8] Analysts: Wayne Mountjoy and J. P. Schuch. Rapid scanning, CO_2 method.
[9] Analysts: R. R. Beins, H. E. Crowe, E. J. Fennelly, Claude Huffman, J. P. Schuch, and J. E. Wilson. Colorimetric method.
[10] Analysts: R. P. Cox, W. D. Goss, and L. F. Rader, Jr. Colorimetric method.
[11] Analysts: C. G. Angelo, G. T. Burrow, R. P. Cox, Mary Finch, W. D. Goss, H. H. Lipp, T. Miller, and J. S. Wahlberg. Colorimetric method.
[12] Analysts: R. R. Beins, G. T. Burrow, and H. E. Crowe. Colorimetric method

TABLE 8.—*Ranges of the geometric means of 19 minor elements in 12 sample groups of the uranium ores, northwestern New Mexico*

[All analyses are spectrographic. Numbers in parentheses are samples below limit of detection]

Percent scale (each element): 0.000015, 0.00003, 0.00007, 0.00015, 0.0003, 0.0007, 0.0015, 0.003, 0.007, 0.015, 0.03, 0.07, 0.15, 0.3, 0.7, 1.5

Ore sample groups By formation, type of host rock [ ], and distinctive structure*		No. of samples SILVER (Ag)	No. of samples COBALT (Co)	No. of samples LANTHANUM (La)
Espinaso Volcanics of Stearns (1943)	[●]*	2	2	2
Popotosa Formation	[○]*	2 (1)	2	2
Baca Formation	[○]	1	1	1 (1)
Dakota Sandstone	[◑]	5 (5)	5	5 (4)
Dakota Sandstone (shale)	[◆]	1 (1)	1	1
Morrison Formation	[●]	18 (18)	18 (1)	18 (16)
Morrison Formation (Woodrow deposit)	[●]*	1	1	1 (1)
Todilto Limestone	[▲]*	31 (30)	31 (4)	31 (31)
Todilto Limestone and Entrada Sandstone	[▲●]*	1 (1)	1	1 (1)
Cutler Formation	[◓]	3 (1)	3	3
San Andres Limestone	[▽]*	1 (1)	1	1 (1)
Madera Limestone	[△]*	2 (1)	2	2 (2)

Ore sample groups		No. of samples BORON (B)	No. of samples CHROMIUM (Cr)	No. of samples MOLYBDENUM (Mo)
Espinaso Volcanics of Stearns (1943)	[●]*	2 (2)	2	2
Popotosa Formation	[○]*	[2]2 (1)	2	2
Baca Formation	[○]	[3]1 (1)	1	1
Dakota Sandstone	[◑]	5 (1)	5	5 (1)
Dakota Sandstone (shale)	[◆]	1	1	1
Morrison Formation	[●]	18 (6)	18	18 (1)
Morrison Formation (Woodrow deposit)	[●]*	1 (1)	1	1
Todilto Limestone	[▲]*	31 (31)	31	31 (17)
Todilto Limestone and Entrada Sandstone	[▲●]*	[3]1 (1)	1	1
Cutler Formation	[◓]	3	3	3 (1)
San Andres Limestone	[▽]*	[3]1 (1)	1	1
Madera Limestone	[△]*	2	2	2

Ore sample groups		No. of samples BARIUM (Ba)	No. of samples COPPER (Cu)	No. of samples NIOBIUM (Nb)
Espinaso Volcanics of Stearns (1943)	[●]*	2	2	2
Popotosa Formation	[○]*	2	2	2
Baca Formation	[○]	1	1	1 (1)
Dakota Sandstone	[◑]	5	5	5 (4)
Dakota Sandstone (shale)	[◆]	1	1	1 (1)
Morrison Formation	[●]	18	18	18 (12)
Morrison Formation (Woodrow deposit)	[●]*	1	1	1 (1)
Todilto Limestone	[▲]*	31	31	31 (31)
Todilto Limestone and Entrada Sandstone	[▲●]*	1	1	1 (1)
Cutler Formation	[◓]	3	3	3 (2)
San Andres Limestone	[▽]*	1	1	1 (1)
Madera Limestone	[△]*	2	2	2 (2)

Ore sample groups		No. of samples BERYLLIUM (Be)	No. of samples GALLIUM (Ga)	No. of samples NEODYMIUM (Nd)
Espinaso Volcanics of Stearns (1943)	[●]*	2 (2)	[5]2	[8]2
Popotosa Formation	[○]*	2	2	2 (2)
Baca Formation	[○]	1	1	1 (1)
Dakota Sandstone	[◑]	5 (5)	5 (5)	5 (5)
Dakota Sandstone (shale)	[◆]	1	1	1 (1)
Morrison Formation	[●]	18 (5)	[6]18 (5)	18 (17)
Morrison Formation (Woodrow deposit)	[●]*	[4]1	[7]1	1 (1)
Todilto Limestone	[▲]*	31 (31)	31 (31)	31 (31)
Todilto Limestone and Entrada Sandstone	[▲●]*	1 (1)	[7]1	1 (1)
Cutler Formation	[◓]	3	3	[9]3 (1)
San Andres Limestone	[▽]*	1 (1)	1 (1)	1 (1)
Madera Limestone	[△]*	2 (2)	[5]2	2 (2)

[1] One sample reported as trace, assumed to be 0.00005.
[2] One sample reported as 0.001.
[3] One sample reported as trace, assumed to be 0.002.
[4] Sample reported as trace, assumed to be 0.0001.
[5] Both samples reported as trace and assumed to be 0.0002.
[6] Includes 2 samples reported as trace and assumed to be 0.0002.
[7] Sample reported as trace, assumed to be 0.0002.
[8] Includes 1 sample reported as trace and assumed to be 0.0002.
[9] Includes 1 sample reported as trace and assumed to be 0.01.

Table 8.—*Ranges of the geometric means of 19 minor elements in 12 sample groups of the uranium ores, northwestern New Mexico*—Continued

Percent scale (both element columns): 0.000015, 0.00003, 0.00007, 0.00015, 0.0003, 0.0007, 0.0015, 0.003, 0.007, 0.015, 0.03, 0.07, 0.15, 0.3, 0.7, 1.5

Ore sample groups (By formation, type of host rock [ ], and distinctive structure*)	Nickel (Ni): No. of samples	Yttrium (Y): No. of samples
Espinaso Volcanics of Stearns (1943)	2	2
Popotosa Formation	2	2
Baca Formation	1	1
Dakota Sandstone	5	5
Dakota Sandstone (shale)	1	1
Morrison Formation	18	18 (2)
Morrison Formation (Woodrow deposit)	1	1
Todilto Limestone	31	[1] 31 (26)
Todilto Limestone and Entrada Sandstone	1	1
Cutler Formation	3	3
San Andres Limestone	1	1 (1)
Madera Limestone	2	2

Ore sample groups	Lead (Pb): No. of samples	Ytterbium (Yb): No. of samples
Espinaso Volcanics of Stearns (1943)	2	2
Popotosa Formation	2	2 (1)
Baca Formation	1	1 (1)
Dakota Sandstone	5 (2)	5 (5)
Dakota Sandstone (shale)	1	1
Morrison Formation	18	17 (17)
Morrison Formation (Woodrow deposit)	1	1 (1)
Todilto Limestone	31	30 (30)
Todilto Limestone and Entrada Sandstone	1	1
Cutler Formation	3	3 (2)
San Andres Limestone	1	1 (1)
Madera Limestone	2	2

Ore sample groups	Scandium (Sc): No. of samples	Zirconium (Zr): No. of samples
Espinaso Volcanics of Stearns (1943)	2	2
Popotosa Formation	2	2
Baca Formation	1	1
Dakota Sandstone	5 (3)	5
Dakota Sandstone (shale)	1	1
Morrison Formation	18 (12)	18
Morrison Formation (Woodrow deposit)	1	1
Todilto Limestone	31 (31)	31
Todilto Limestone and Entrada Sandstone	1 (1)	1
Cutler Formation	3	3
San Andres Limestone	1 (1)	1
Madera Limestone	2	2

Ore sample groups	Strontium (Sr): No. of samples
Espinaso Volcanics of Stearns (1943)	2
Popotosa Formation	2
Baca Formation	1
Dakota Sandstone	5
Dakota Sandstone (shale)	1
Morrison Formation	18
Morrison Formation (Woodrow deposit)	1
Todilto Limestone	31
Todilto Limestone and Entrada Sandstone	1
Cutler Formation	3
San Andres Limestone	1
Madera Limestone	2

[1] Includes 2 samples reported as trace and assumed to be 0.001.

EXPLANATION

Range in content of samples. Dashed where uncertain

Geometric mean of all samples reported as trace or more. Questioned where doubtful

−o Approximate limit of sensitivity where the element is undetected in all samples

−o −o Approximate limits of sensitivities where they vary between samples. All samples undetected and below either or both limits

Ore sample groups

- [ ]* Tertiary igneous breccia; in footwall of igneous dike
- [ ]* Tertiary sandstone; in hanging wall of low-angle fault
- [ ] Tertiary sandstone
- [ ] Cretaceous sandstone
- [ ] Cretaceous shale
- [ ] Jurassic sandstone
- [ ]* Jurassic sandstone (Woodrow deposit); in near-vertical breccia pipe
- [ ]* Jurassic limestone
- [ ]* Jurassic limestone and sandstone
- [ ] Permian sandstone
- [ ]* Permian limestone; in footwall of high-angle fault
- [ ]* Pennsylvanian limestone; in footwall of high-angle fault

Table 9.—*Ranges of concentration and the geometric means of uranium, vanadium pentoxide, sulfur, phosphate, organic carbon, arsenic, fluorine, selenium, and zinc in 12 sample groups of the uranium ores, northwestern New Mexico*

[Analyses are chemical except for some samples of V_2O_5. Where no chemical analyses are available or show an assay of <0.10 percent V_2O_5, spectrographic analyses are used by conversion of V to V_2O_5.]

Percent scale (uranium, vanadium pentoxide, sulfur, organic carbon): 0.05, 0.1, 0.5, 1.0, 5.0, 10.0
Percent scale (phosphate): 0.010, 0.020, 0.030, 0.040

Ore sample groups By formation, type of host rock ( ), and distinctive structure*		No. of samples: Uranium (U)	No. of samples: Phosphate (P_2O_5)
Espinaso Volcanics of Stearns (1943)	● |*	2	0 No data
Popotosa Formation	○ |*	2	0 No data
Baca Formation	○ |	1	0 No data
Dakota Sandstone	◗ |	5	0 No data
Dakota Sandstone (shale)	◒ |	1	0 No data
Morrison Formation	● |	19	0 No data
Morrison Formation (Woodrow deposit)	● |*	1	0 No data
Todilto Limestone	▲ |*	31	31
Todilto Limestone and Entrada Sandstone	▲● |*	1	1
Cutler Formation	● |	3	0 No data
San Andres Limestone	▼ |*	1	1
Madera Limestone	△ |*	2	0 No data

Ore sample groups		No. of samples: Vanadium pentoxide (V_2O_5)	No. of samples: Sulfur (S)	No. of samples: Organic carbon (C)
Espinaso Volcanics of Stearns (1943)	● |*	2	2	0 No data
Popotosa Formation	○ |*	2	1	1
Baca Formation	○ |	1	0 No data	0 No data
Dakota Sandstone	◗ |	5	[illegible]	1
Dakota Sandstone (shale)	◒ |	1	0 No data	0 No data
Morrison Formation	● |	18	9	(5) 38 [1]
Morrison Formation (Woodrow deposit)	● |*	1	1	0 No data
Todilto Limestone	▲ |*	31	25	24
Todilto Limestone and Entrada Sandstone	▲● |*	1	[illegible]	0 No data
Cutler Formation	● |	3	[illegible]	0 No data
San Andres Limestone	▼ |*	1	1	0 No data
Madera Limestone	△ |*	2	2	0 No data

[1] Number in parentheses is samples below limit of detection, each reported as < 0.3 and assumed to be 0.2 ppm.

EXPLANATION

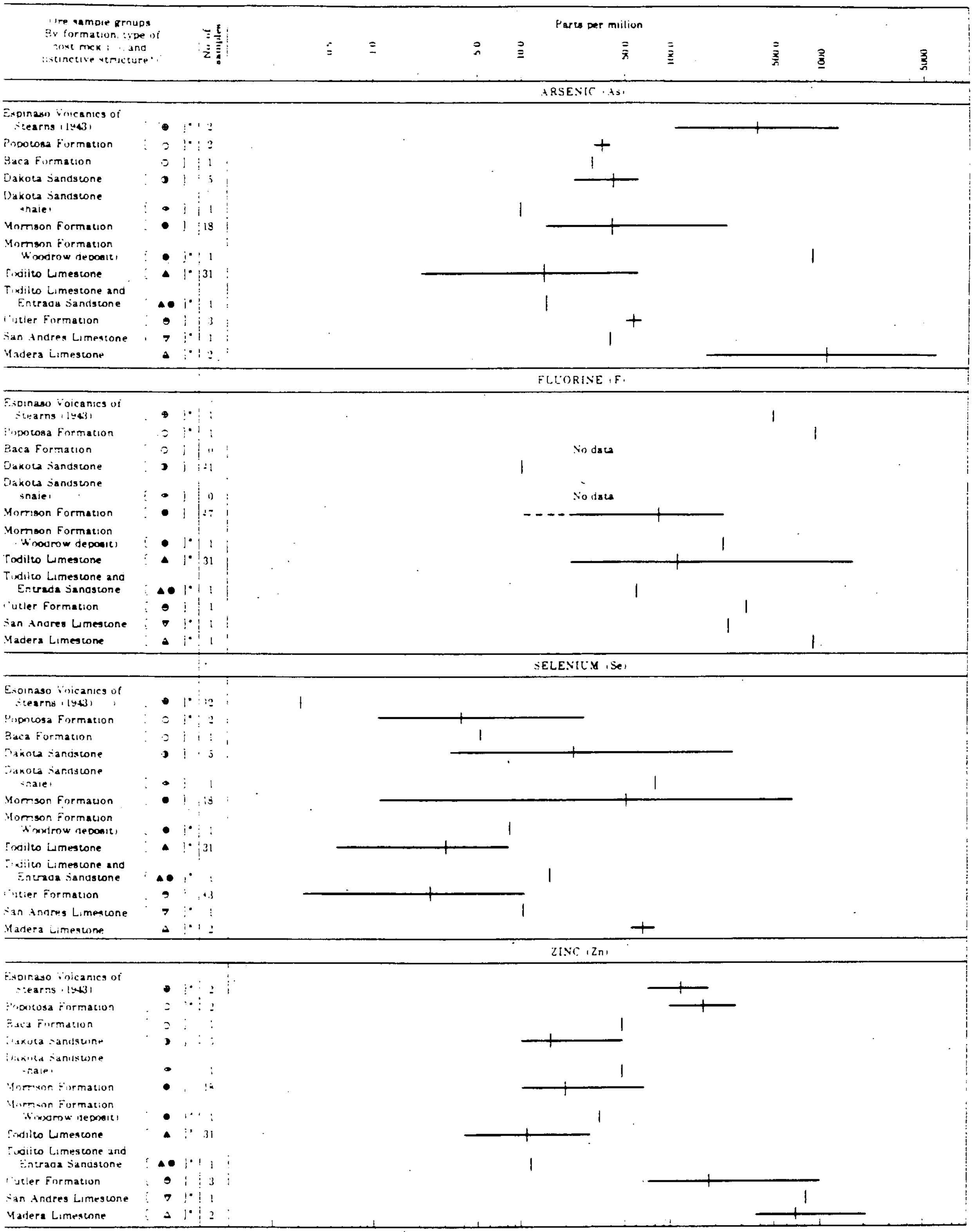
←— Range in content of samples —→
Dashed where uncertain

Geometric mean of all samples reported as trace or more, except where noted

Ore sample groups

- ● |* Tertiary igneous breccia; in footwall of igneous dike
- ○ |* Tertiary sandstone; in hanging wall of low-angle fault
- ○ | Tertiary sandstone
- ◗ | Cretaceous sandstone
- ◒ | Cretaceous shale
- ● | Jurassic sandstone
- ● |* Jurassic sandstone (Woodrow deposit), in near-vertical breccia pipe
- ▲ |* Jurassic limestone
- ▲● |* Jurassic limestone and sandstone
- ● | Permian sandstone
- ▼ |* Permian limestone, in footwall of high-angle fault
- △ |* Pennsylvanian limestone, in footwall of high-angle fault

BLE 9.—*Ranges of concentration and the geometric means of uranium, vanadium pentoxide, sulfur, phosphate, organic carbon, arsenic, fluorine, selenium, and zinc in 12 sample groups of the uranium ores, northwestern New Mexico*—Continued



[1]One sample reported as < 20, assumed to be 10 ppm.
Both samples reported as < 0.5, assumed to be 0.3 ppm.
[3]One sample reported as < 0.5, assumed to be 0.3 ppm.

TABLE 10.—*Geometric means of 16 selected elements in the ore sample groups of classes 1 and 2*

[0, looked for but not found; <, less than amount shown; leaders (......), not looked for; ~, approximate amount shown. Analyses are in percent, except as otherwise indicated]

Ore sample groups (by host rock)	Ag	Al	Co	Cr	Cu	Fe	Mo	Ni	Pb	U	V_2O_5	S	As (Parts per million)	F (Parts per million)	Se (Parts per million)	Zn (Parts per million)
Groups of class 1																
Baca Formation	0.00003	3	0.0003	0.0015	0.003	1.5	0.0007	0.0015	0.003	0.14	0.27	......	30	......	5	50
Dakota Sandstone	0	2.6	.0005	.001	.04	.7	.0015	.001	<.0007	.16	.06	0.10	40	~10	21	15
Dakota sandstone (shale)	0	7	.0007	.003	.003	.7	.0015	.0015	.0015	.15	.01	......	10	......	75	70
Morrison Formation	0	4.8	.0008	.002	.04	1.4	.005	.0015	.006	.25	.50	.3	40	83	48	20
Todilto Limestone	<.00005	1.5	.0004	.001	.002	.3	<.0011	.0007	.005	.14	.14	.04	14	108	2.9	11
Todilto Limestone and Entrada Sandstone	0	3	.0015	.003	.003	.7	.0006	.0007	.003	[illegible]	.13	.08	15	60	15	12
Cutler Formation	~.00003	~9	.02	.004	.09	2.4	<.0014	.002	.025	.10	.15	.07	50	320	2.3	153
Groups of class 2																
Espinaso Volcanics of Stearns (1943) [1]	0.0003	4.6	0.02	0.015	1.5	4.6	0.005	0.09	0.0015	0.14	0.02	4.0	360	480	<.5	118
Popotosa Formation	<.000015	15	.05	.003	.05	2.1	.003	.005	.015	.13	.03	.11	35	920	3.7	167
Morrison Formation (Woodrow deposit) [2]	.003	3	.015	.0015	.015	7	.003	.007	.03	1.16	.03	6.6	800	220	5	25
San Andres Limestone	0	1.5	.0015	.003	.003	.7	.0015	.007	.007	.22	.43	.06	41	240	10	830
Madera Limestone [3]	~.0004	3	.0015	.0046	.014	3.2	.007	.003	.05	.12	.06	1.2	1,033	590	61	733

[1] This sample group also contains 0.03 Ce, 0.015 La, ~0.01 Nd, and 0.12 Sr; 1 sample contains 0.003 Ge.
[2] This sample group also contains a trace of Tl.
[3] One sample in this sample group also contains 0.015 Sb and 0.015 Tl.

MORRISON FORMATION

Most data were obtained for the ore sample group of the Morrison Formation, the most important ore group in the area, from the standpoint of ore production and mine reserves. With the exception of some redistributed deposits in the Ambrosia Lake district and possibly the Gallup district, this ore group shows no direct relation to tectonic structures and, with the exception of the ores in the Salt Wash Member, no stratigraphic or geographic differences.

In general, the ore group in the Morrison shows a somewhat greater range in content of many elements than most other groups of class 1. This is principally the result of the greater number of samples, as indicated by the similar geometric means for the respective elements among the several sample groups (tables 7–9). An exception is vanadium, which has a relatively wide range and an average content that is much greater than that of any of the other groups. (See vanadium pentoxide, table 9.) These differences are reflected mostly by sample 254040 (table 5), which was taken from the northwestern part of the area where ores in the Salt Wash Member have an average U:V ratio of 1:7 (See table 2, Shiprock district.) Because the Salt Wash has a rather limited distribution in northwestern New Mexico, the ores that have a high vanadium content are restricted geographically as well as stratigraphically.

MORRISON FORMATION (WOODROW DEPOSIT)

The Woodrow deposit in the Morrison Formation differs from the groups in class 1 in its high content of 10 elements, the presence of coarse-grained coffinite in the ore, and the close association of the deposit with a faulted pipelike structural feature. These differences justify assignment of the Woodrow deposit to class 2.

The contents of each of the following nine elements in the Woodrow deposit are greater than the highest respective contents of the sample groups in class 1 by the following multiples: silver, >6×; cobalt, 7½×; copper, 3½×; iron, 3×; nickel, 3½×; lead, 5×; uranium, 4½×; sulfur, 22×; and arsenic, 16×. The contents of lead and copper in the Woodrow are about the same or less than in the group in the Cutler Formation, which contains an appreciably higher content of these and some other elements than the groups in class 1. This matter is discussed below under Cutler Formation. The Woodrow also contains a trace of thallium, which is rarely detected in deposits of the peneconcordant type, and it also has a relatively high sulfide mineral content, which is expressed in the ore principally as pyrite and marcasite; this content is indicated by the high amounts of iron and sulfur (table 10). Conversely, the Woodrow is low in vanadium.

The mineralogy of the Woodrow deposit is similar to that of the group in the Morrison Formation, with two exceptions: one is its relatively high sulfide mineral content, and the other is the presence of coarse-grained coffinite (Hilpert and Moench, 1960, p. 446) which occurs only in a fine-grained or earthy form in other deposits in the Morrison Formation as well as in all other peneconcordant deposits. Thus, the significant differences between the Woodrow deposit and groups of class 1 are the high grade of the deposit, the presence of coarse-grained coffinite in the ore, and the association of the deposit with a faulted pipelike structural feature.

Santa Fe Group (Miocene to Pleistocene?).—Several uranium deposits are known in rocks of the Santa Fe Group, but they generally are small and superficial. The resource outlook, however, is considered to range from poor at the outcrop to good in the subsurface, similar to the Galisteo and Popotosa Formations. The Santa Fe Group is widely exposed, but in most places only the upper few hundred feet of the sequence is represented; elsewhere the beds are covered by alluvium and surficial debris. Little, if any, exploration has been done for deposits in the unexposed beds. The great extent and thickness of these beds, and the favorableness of many of them for containing uranium deposits, offer a good potential for deposits that may range in size from small to large.

Older volcanic rocks of Jemez Mountains, Espinaso Volcanics of Stearns (1943), Cienequilla Limburgite of Stearns (1953), and intrusive rocks of varied composition and form.—One medium-sized vein deposit occurs in the Espinaso Volcanics of Stearns (1943) on the eastern side of the Los Cerrillos district; a few other scattered small deposits, which are mostly surficial accumulations, occur in various types of intrusive and extrusive igneous rocks, mainly along the Rio Grande trough. The uranium resources in these rocks are small and the outlook is poor for finding more than a few small, or possibly medium-sized, deposits in them. The best potential is in the Los Cerrillos and Ortiz mining districts, where some uraniferous vein deposits might be found in association with the base-metal deposits.

AREAS RECOMMENDED FOR EXPLORATION

The principal uranium resources in northwestern New Mexico are in peneconcordant deposits, mostly in sandstone, partly in limestone, and to some extent in carbonaceous shale and coal. Most of these resources are along the margins of sedimentary basins, the most important of these areas being the southern and western parts of the San Juan Basin.

Of greatest importance is the southern part of the basin. On the basis of the frequency of distribution of the known deposits and their geologic relations, the deposits in this area are restricted to a zone or belt north of the outcrop of the Jurassic rocks which is at least 20 miles wide and which has been referred to as the southern San Juan Basin mineral belt (Hilpert and Moench, 1960). The northern limit of the belt is adjusted here to include the known areas of most intensive structural deformation during Late Jurassic time. This deformation is recognized as the prime control on the uranium deposits in the Morrison Formation and Todilto Limestone. As drawn, the northern limit of the belt extends from near the northern pinchout of the Jackpile sandstone northwestward, parallel to the reconstructed boundary of the Jurassic basin of deposition, to the outcrop of the Morrison Formation on the western side of the Sa Juan Basin (fig. 20). Included in the belt are th Jackpile trough in the Laguna district (roughl marked by the Jackpile sandstone) and the main ore bearing sandstone mass in the Ambrosia Lake distric (areas C and D, respectively, fig. 20). Other structur ally deformed areas probably occur in the wester part of the belt and along its north margin. Certainl such areas will not be expected to end abruptly wher the north margin is indicated. The boundary is draw to show approximately where the deformation becam less intensive northward.

Included in the belt is the part of the limestone un of the Todilto Limestone that is 15 feet or mor thick. This part includes almost all the mine reserve has yielded almost all the ore, and probably contai most of the uranium resources in the Todilto. Whe the limestone unit of the Todilto was thickest, it pro ably received the most intensive deformation an thus is considered most favorable for deposits. T Todilto generally lies about 400–500 feet below t base of the Morrison Formation. Because of this ge eral depth and the smaller deposits in it, the Todil is not of immediate economic interest except where is not deeply buried.

The mineral belt also contains the most favorab ground for uranium deposits in the Dakota San stone, although the Jurassic deformation probably h little, if any, influence on them. The best ground in the western part of the belt, where channel-ty sandstone lenses are largest and thickest. This area near the margin of the Dakota basin of depositi Depths to the base of the Dakota will generally about 500 feet nearer the surface than the base of Morrison. Although the size of the deposits in Dakota is about the same as the size of the ones the Todilto, the deposits in the Dakota are mo amenable to exploration and development, which be coordinated with exploration for the deeper generally larger deposits in the Morrison Formati

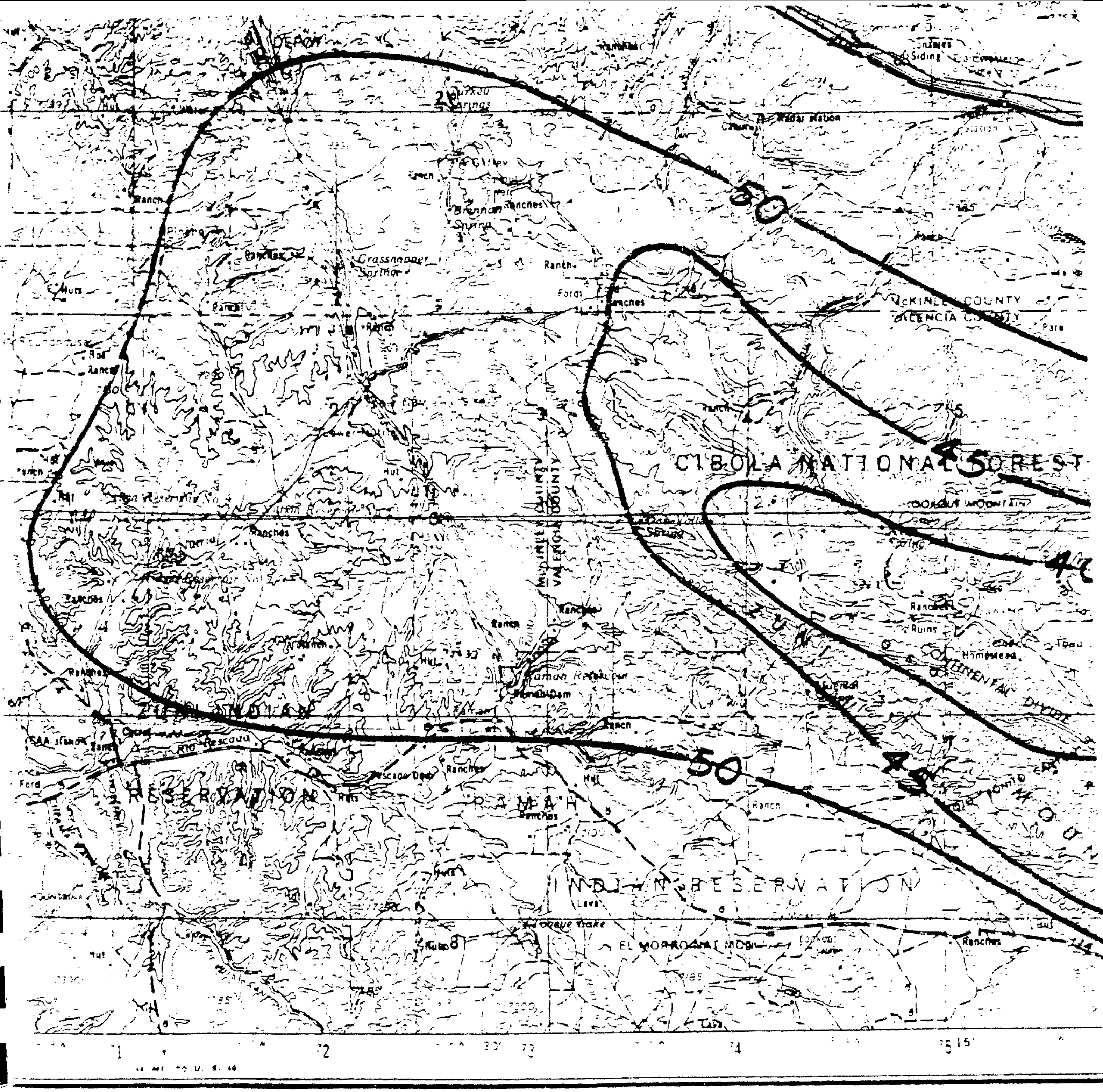
In the western part of the San Juan Basin s stantial resources may also be found in the Shipr district in the Salt Wash Member of the Morri Formation and in the Chuska district in the Recapt Member of the Morrison (fig. 20, areas A and B, spectively). Each of these areas defines the thic part of the respective members where they appare ly occupy eastward-trending structural depressio Deposits in these rocks are expected to range fr small to medium in size, similar to the ones a

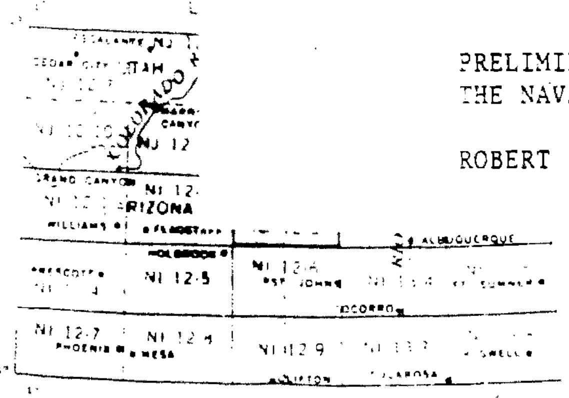
REFERENCE # 12

NAVAJO SUPERFUND OFFICE

BROWN VANDEVER URANIUM MINE REFERENCE MATERIAL

MAY, '90 P. MOLLOY





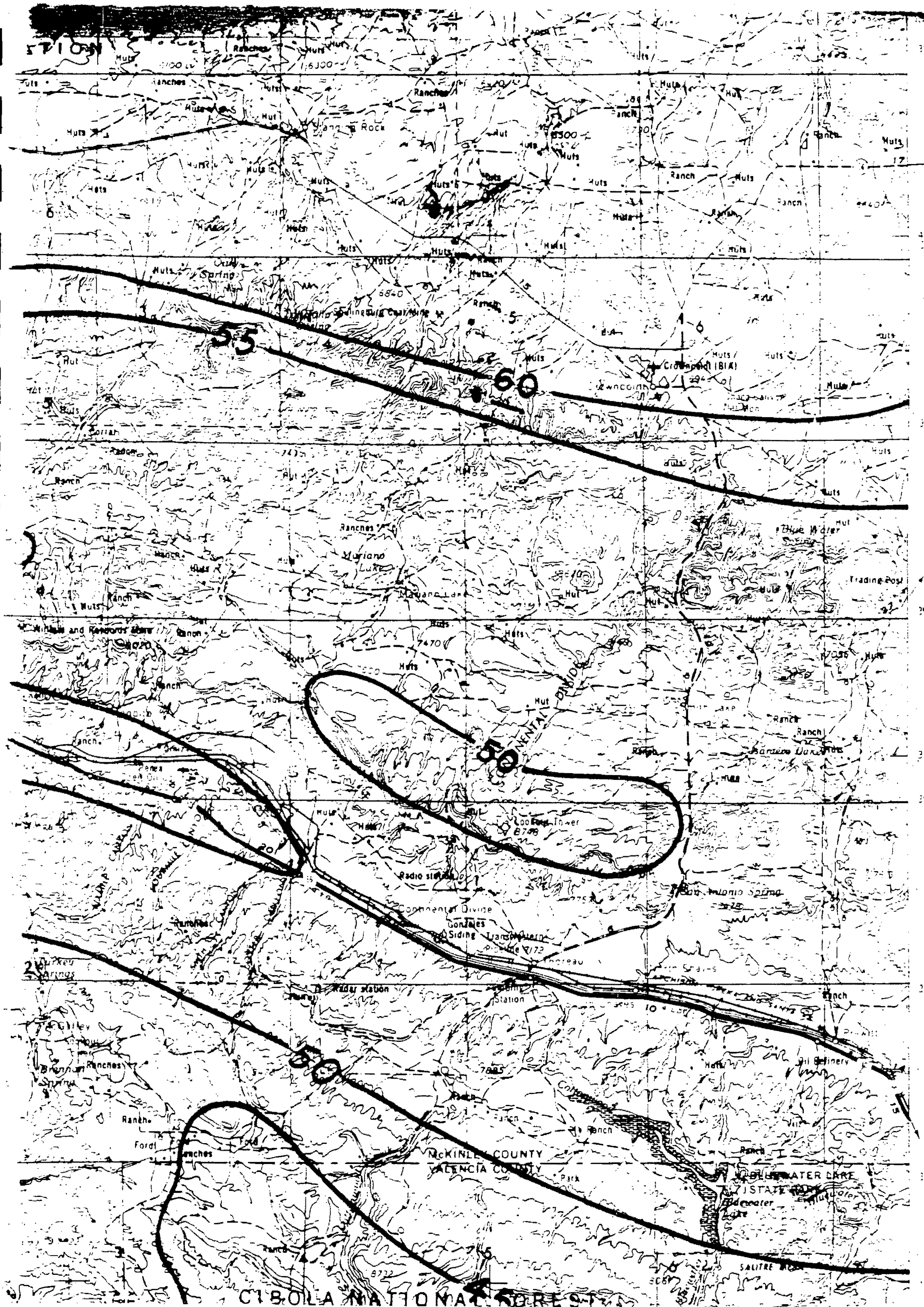
PRELIMINARY AVERAGE ANNUAL LAKE EVAPORATION FOR THE NAVAJO RESERVATION IN INCHES OF WATER

ROBERT BECKER, 1985.

19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

TOWNSHIP OR RANGE LINE

AND GRANT BOUNDARY


55
60
50
50
Mariano Lake
Radio station
Continental Divide
Radar station
Oil Refinery
Trading Post
McKINLEY COUNTY
VALENCIA COUNTY
STATE PARK
CIBOLA NATIONAL FOREST

REFERENCE # 13

NAVAJO SUPERFUND OFFICE

BROWN VANDEVER URANIUM MINE REFERENCE MATERIAL

MAY, '90 P. MOLLOY

code of federal regulations

Protection of Environment

40

PARTS 190 to 399

Revised as of July 1, 1987

CONTAINING
A CODIFICATION OF DOCUMENTS
OF GENERAL APPLICABILITY
AND FUTURE EFFECT

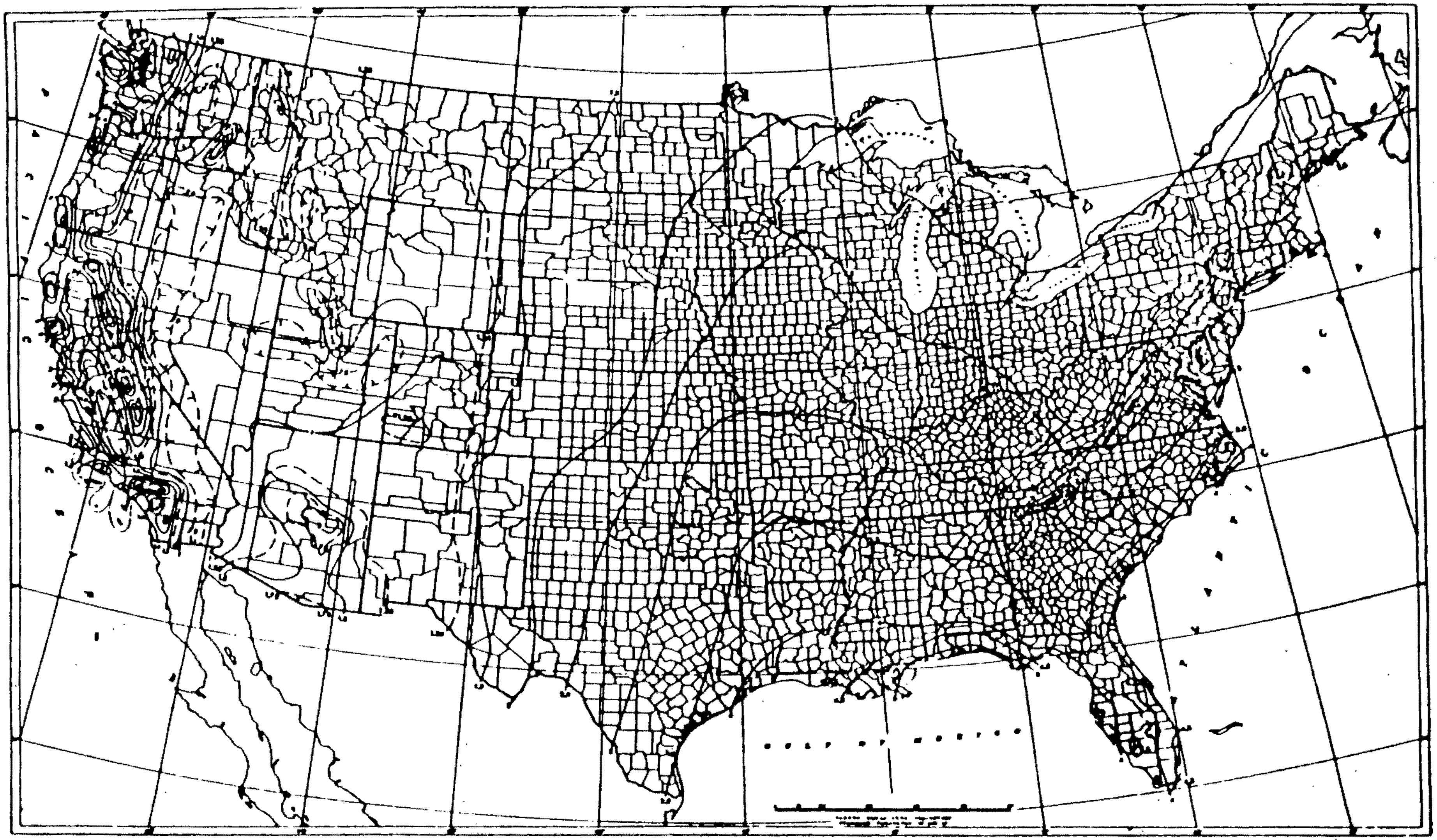
AS OF JULY 1, 1987

With Ancillaries

Published by
the Office of the Federal Register
National Archives and Records
Administration

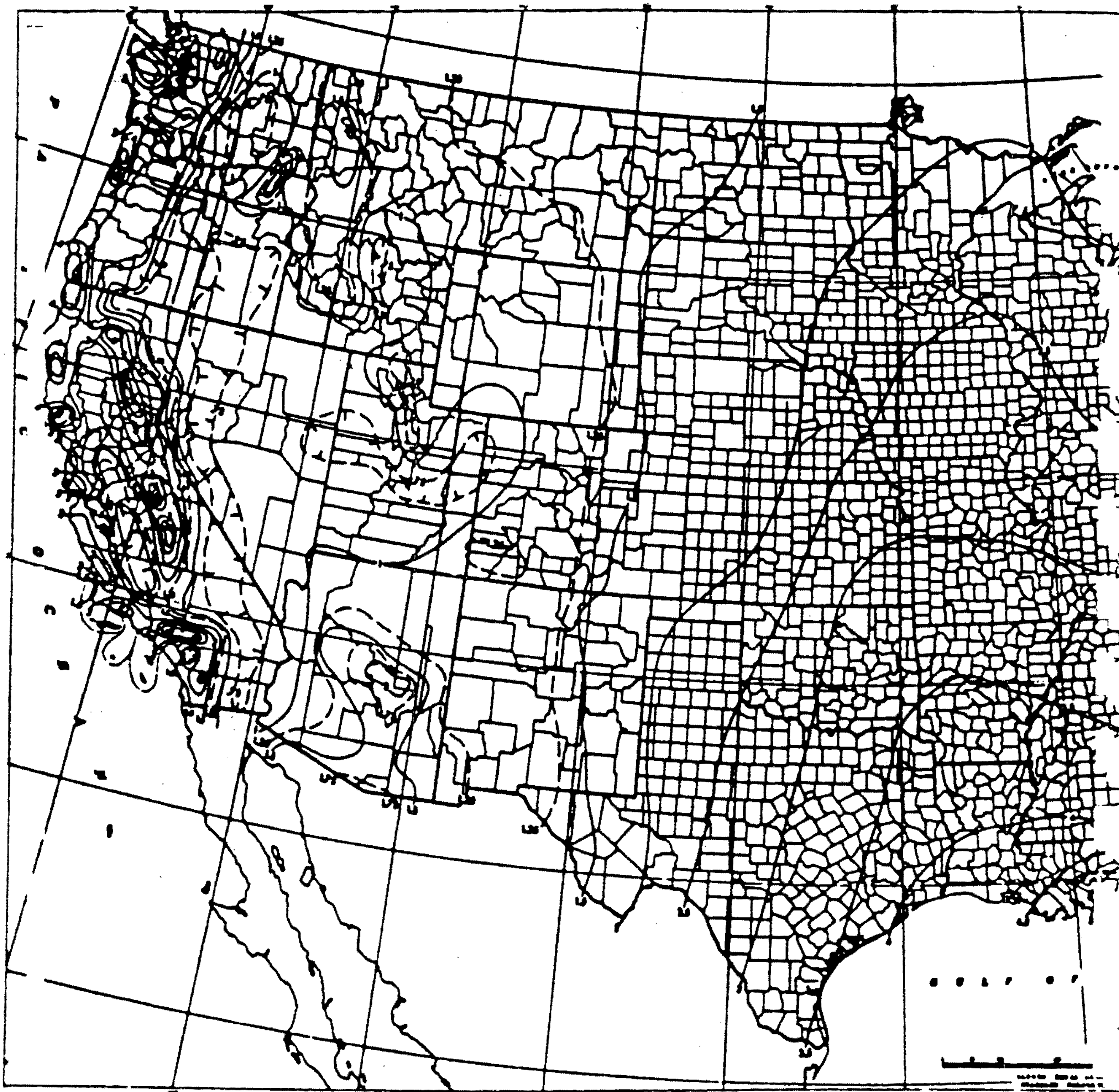
as a Special Edition of
the Federal Register

THE NATIONAL ARCHIVES OF THE UNITED STATES • 1934 •



Source: Rainfall Frequency Atlas of the United States, Technical Paper No. 40, U.S. Department of Commerce, U.S. Government Printing Office, Washington, D.C., 1963

FIGURE 8
1-YEAR 24-HOUR RAINFALL
(INCHES)



So :e: Rainfall Frequency Atlas of the United States, Technical Paper No. 40, U.S. Department of Commerce, U.S. Government P

1.26 IN.

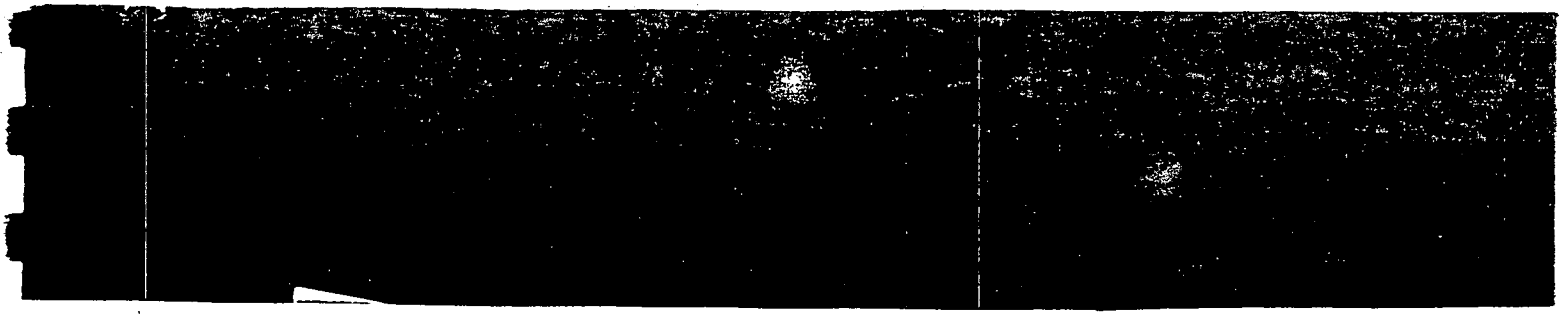
FIGURE 8
1-YEAR 24-HOUR RAINFALL
(INCHES)

REFERENCE # 14

NAVAJO SUPERFUND OFFICE

BROWN VANDEVER URANIUM MINE REFERENCE MATERIAL

MAY, '90 P. MOLLOY



PAGE#1

- 9TH FRAME - DRUM #27 (ELDRIN)

□ KLEENGARD - KIMBERLY CLARK

* - MORE TEAR RESIST. THAN TYVEK

◊ WHOLE BODY COUNTS ! ***

APRIL 11, 1990: B. VANDEVER MINE (HAYSTACK BUTTE AREA)

◊ @ NSO
- LUDLUM #19 - 7 $\mu R \cdot hr^{-1}$
- ESP-II & RATEMETER $\simeq 7(10^3)$ cpm

◊ PREWITT SITE
- 2 FRAMES OF RECLAMATION WORK

◊ TURN OFF TO HAYSTACK BUTTE
- ○ BACKGROUND (LUDLUM #19)
  - @ SHINE ~ 5 $\mu R \cdot hr^{-1}$
  - @ FACE ~ SAME
- ○ B'GRND (ESP-II
  - @ SHINE ~ 6.5 (10^3) cpm: FACE SAME

◊ od. RESET @ 17218.4 MI.

◊ 3rd FR. - REFERENT FRAME FOR B'GRND CHECK (NOTE EXTENSIVE SURFACE WORKS, RIGHT CNTR MIDDLE GROUND)

◊ 17220 (1.6)
- ○ 2 FRAMES OF RES. W OF HAYSTACK BUTTE
  - 6TH FR. NOTE HAYSTACK B. IN MIDDLE GROUND AS REFERENT ALSO WINDMILL

◊ 17220.9 (
- 6TH FR
HAYSTAC

◊ 17222.4 (
- 1 RES. &

◊ 17223.7
- BROWN
- 1 RES.

◊ 3 FRAM
- 7TH FR.
- 8TH FR
RES
- 9TH FR
DZ+L
- 10TH FR

◊ 1 FRAME
(@ B. VAN
- B'GRND
- ○ LUDLUM
- ○ ESP-II
- ○ SHINE
- ○ SHINE

◊ 12TH FR.

◊ 13TH FR.
- ○ LUDLUM
SHINE

◊ B. VANDE
- STOPES
400 yd

** - BORRGO

DM #27 (ELDRIN)
BERLY CLARK
1ST. THAN

NTS! ***

EVER MINE
AREA)

$\cdot hr^{-1}$
ER $\simeq 7(10^3)$ cpm

ECLAMATION

TACK BUTTE
LUM #19)
2$\cdot hr^{-1}$
=

(10^3) cpm:

218.4 mi.
REHT FRAME
CK (NOTE EXTEN-
ORKS, RIGHT CNTR

S. W OF HAYSTACK

AYSTACK B. IN
S ~~REFERENT~~

◇ 17220.9 (2.2 od.)
- 6TH FR. - RES. (2) W OF HAYSTACK B.

◇ 17222.4 (3.7 od.)
- 1 RES & CHURCH - NO PICTURE

◇ 17223.7 (5.0 od.)
- BROWN VANDEVER RES.
- 1 RES. @ THIS LOCATION

◇ 3 FRAMES
- 7TH FR. - TRENCH CUT
- 8TH FR. - GOPHERINGS N OF RES
- 9TH FR. - REFERENT TSCHDZ11
- 10TH FR. - MARTINEZ RES'S.

◇ 1 FRAME, REFERENT, B'GRND (@ B. VANDEVER'S SON'S RES.
- B'GRND (11TH FR.)
- o LUDLUM #19 - 24 $\mu R \cdot hr^{-1}$ (FACE)
- o ESP II - $2.15(10^4)$ cpm (FACE)
- o SHINE - SAME
- o SHINE - $2.25(10^4)$ cpm

◇ 12TH FR. - INCLINED ADIT NOTE DRAINAGE INTO

◇ 13TH FR. - TRENCH & RXR BED
o LUDLUM #19 - 21 $\mu R \cdot hr^{-1}$ @ SHINE

◇ B. VANDEVER
- "STOPES ARE 400 yds (ESE), 400 yds (N)"
** - "BORREGO PASS MINE; 300' DP."

[redacted]

PAGE#3

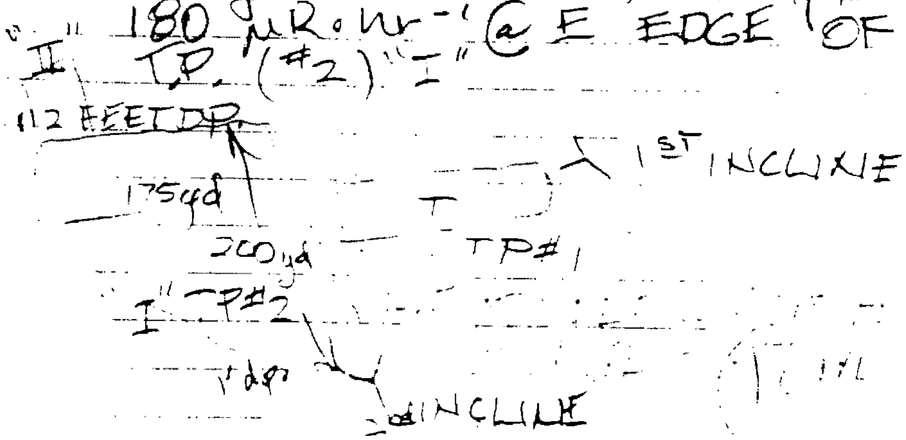
◇ TOP OF T.P. NE OF INCLINE 80 μR·hr⁻¹

◇ HOT ROCK — .1 mR·hr⁻¹
- 14TH FR.

◇ 350 μR·hr⁻¹ @ LOADING "BAY" EDGE; 400 μR·hr⁻¹ @ CTR (SHRINE) 650 μR·hr⁻¹ (@ FACE), VANADATE OBSERVED

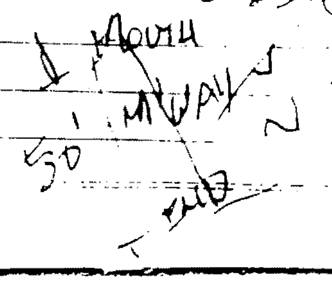
◇ 2nd INCLINE - FACE 160 μR·hr⁻¹

◇ TAILINGS STREWN 200 yds × 175 yds APPROX. 1 foot dp.; 180 μR·hr⁻¹ @ E EDGE OF T.P. (#2) "I"



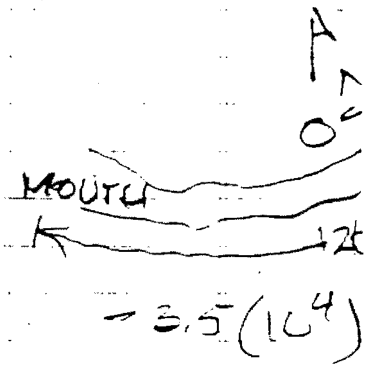
◇ 380 μR·hr⁻¹ @ "II"
☆ 15TH FR - TP#2
☆ 16TH FR - DRAINAGE (E)

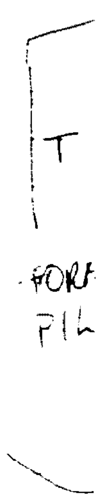
▫ IN DRAINAGE (E) AND S OF TP'S
- MOUTH - 5 (10⁴) cpm
- MIDWAY - 6.5 (10⁴)
- END - 3.25 (10⁴)



▫ @ 100 ' ; C
6.5 (104) (
- 17TH FEA
- 18TH "
(E)

▫ DRAINAG





▫ DUE S OF
- 20TH FR. -
- 21ST FR. -
LOOKING

▫ DUE W OF
E W/ TAIL
- 22nd FR

E OF INCLINE
.1 mR·hr⁻¹

LOADING "BAY"
r⁻¹ @ CTE (SHALE)
FACE), VANADATE

FACE 160 μR·hr⁻¹
A 200 uds /
1 foot dp. @
E EDGE OF

1ST INCLINE

-#1

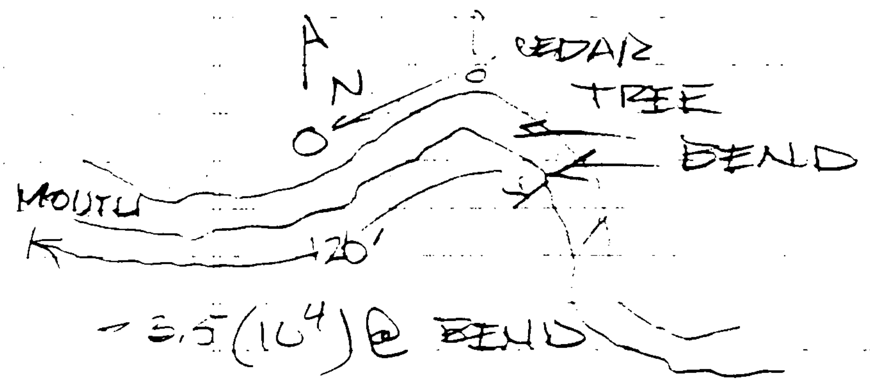
E

@ "I"

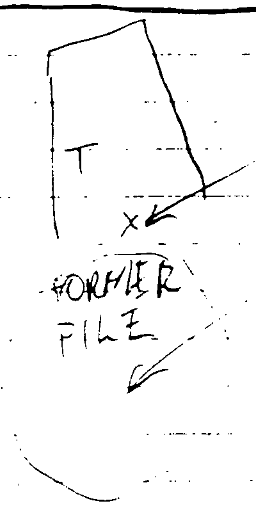
NAGE (E)
S OF TP's
ul

J @ 100' S CEDAR TREE, IN DR.
6.5 (10⁴) CPM
- 17TH FRAME (COLOC. OF 6.5 (10⁴)
- 18TH " - DOWN DRAINAGE (E)

□ DRAINAGE



~3.5 (10⁴) @ BEND



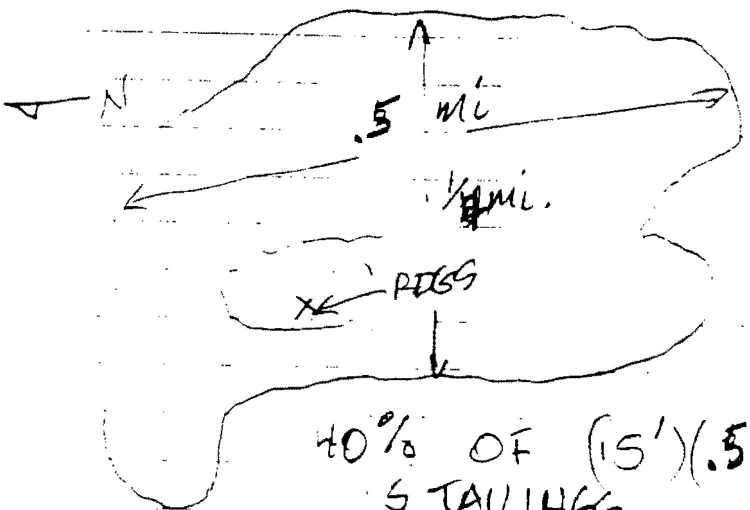
19TH FR.

-2.5 (x10⁴) cpm
"SPOT"

□ DUE S OF MARTINEZ RES.
- 20TH FR. - STRAT. SECTION / HUSK I
- 21ST FR. - B. VANDERVER OUTFIT
LOOKING WSW
□ DUE W OF B. VANDEVER, ROAD GRAVE
ED W/ TAILINGS (ESP-II ~ 10⁵ CPM)
- 22ND FR - LOOKING E, NOTE: MT. TAYLO
IN BACKGROUND AS REF.

[redacted]

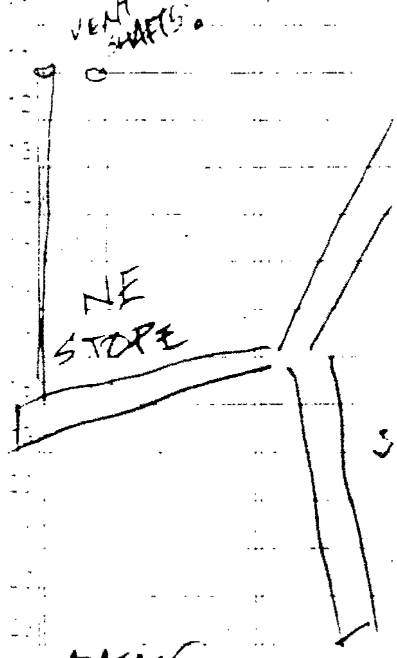
- ESP II - 5.2 (10") cpm
- LUDLUM #19 — 100 μR·hr⁻¹
★ - NOTE: BOTH RDGS @ SHINE
☐ @ .8 mi. W OF B. VANDEVER RES.
- ~~NANA~~-A-BAH VANDEVER MINE?
* FRAMES 23 AND 24
☐ @ EXTENSIVE SURFACE WORKS W. OF B.V. RESIDENCE
- FRAMES 25 THRU 28 - SEMI-PANORAMA



40% OF (15')(.5mi)(.25mi)
S TAILINGS

☐ @ OVERLOOK
- 29TH FR - LOOKING N, RES. IN CTR MIDDLEGROUND
- 30TH FR - LKG NW, WESTERN EXTENT OF SURFACE WORKS
- 31ST FR - LKG NE, EASTERN EXTENT OF SURFACE WORKS; NOTE TAILINGS FAR CENTER M'GRND
☐ @ TIMBERED INCLINE
- 33rd FR.
☐ 32nd FR. - LKG S. SURFACE WORKS

CONT'D @ T
- ESP-II
- LUD #19
★ B. VANDEVE
- "TIMB. S
- "DRILLING
- "RXR L
- "B.V. -
1/4 SEC



~~★★★~~ @ DUE N
- 33rd FR.
~~XXXXX~~
- AND MR
☐ @ TURN OFF
- 34TH FR
MINE IN
B'GRND

) CPM
00 μR · hr^{-1}
DGS @ SHINE
B. VANDEVER

VANDEVER MINE:
AND 24
FACE WORKS OF W.
CE
THRU 28 – SEMI –

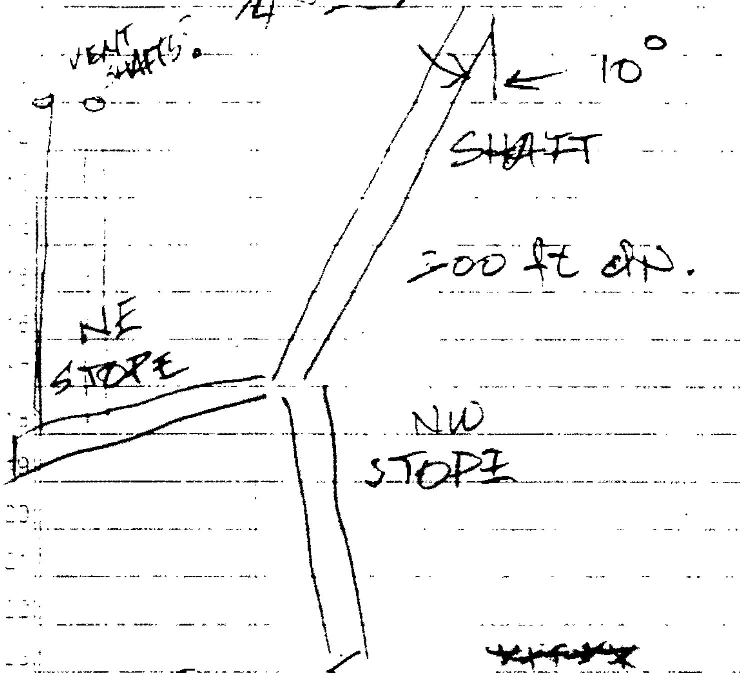
MI.

OF (15')(.5 mi.)(.25 mi.)
ILINGS

NG N, RES. IN
HD
NW, WESTERN EX-
E WORKS
NE, EASTERN EX-
CE WORKS: NOTE
CENTER M'GRND
INE

SURFACE WORKS

CONT'D @ TIMB. SHAFT
– ESP-II – 10^4 CPM
– LUD #19 – 10 μR hr^{-1}
★ B. VANDEVER:
– "TIMB. SHAFT ~ 300 ft DEEP"
– "DRILLING (EXPL.) NNW OF SHAFT"
– "RXR LAND W & SE OF B.V."
– "B.V. = ¼ SEC. 18, B.V. 6 MOTH ¼ SEC."



~~XXX~~ @ DUE N OF SURFACE WORKS
– 33rd FR. – VENT. SHAFTS: VECTRA

– AND MR. BROWN VANDEVER
□ @ TURN OFF TO B.V.
– 34th FR – DRAINAGE E OF B.V. MINE (NOTE: MT. TAYLOR IN B'GRND AS REFERENT)

- ☐ @ DUE S OF H'STK B.
  - 35TH FR. - ARTESIAN WELL USED FOR STOCK WATER AND ?
- ☐ @ DUE E OF H'STK B.
  - FRAMES 36 THRU 39 - HAYSTACK COMMUNITY/ RES'S.
  - FRAME 40 SAA
- ☐ @ WELL 16T-552
  - DIP VAT & TANK - 41ST FR
  - WELL NOT FUNCTIONING
- ☐ BACK TO THE B.S. GRINDER
  • • • •

APRIL 12, 1990: STF. MTG.

- ☐ WABOS, WABOS, WABOS, WABOS
- ☐ LEE BIGWATER
  - "WIFE IS LAB. S'VISOR @ SAGE MEM."
- ☐ LTL SPOKE (TECH. STF GOT STUCK AGAIN)
- ○☆ CHRIS PETRE :: WILL BRING,
  - HNO3, NALGENE 1 l, 500 ml, 8-OZ. SOIL SAMPLE JARS, DL, COND. METERS
  - STAY IN FARMINGTON? JEC FOR CHRIS P.
- ○ CIBOLA MED. $262
  - ☐ CHECK OUT VEH. FROM BEVERLY NEE
  - ☐ GET TA B4
  - ☐ "50YS" AGAIN
- ○☆ MONTHLY REPORT - APRIL 27, 1990

NSO :: NEPA SAME

◇ OMB: "REG. IX - LEAD AGENCY"

*◇ CEQ: IS MANDATED TO DO THIS

LOUISE? HOLA

REFERENCE # 15

NAVAJO SUPERFUND OFFICE

BROWN VANDEVER URANIUM MINE REFERENCE MATERIAL

MAY, '90 P. VOLLCY

RADIATION PROTECTION CATALOG

Eberline A subsidiary of Thermo Instrument Systems Inc.

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Santa Fe, New Mexico 87504-2108
(505) 471-3232 TLX: 66-0438 EIC SFE

Eberline A subsidiary of Thermo Instrument Systems Inc.

Service Centers

CERTIFIED CALIBRATION REPAIR

Eberline Instruments, Certified Calibration ("non-removable" contaminated instruments also calibrated)	Call Service center for prices
Other Manufacturer's Instruments, Certified Calibration	$115.00 each
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Service Engineer at Customer's site	$730/day plus expenses at cost

MISCELLANEOUS

1. Turn Around Time:

   Calibration: Seven (7) working days on Eberline Instruments.
   Repair: Fifteen (15) working days on Eberline instruments unless parts have to be ordered.

2. FOB Santa Fe, New Mexico, or West Columbia, South Carolina.

3. Instruments for warranty repair, repair, or calibration must be sent to:

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   P.O. Box 2108, 504 Airport Road
   Santa Fe, New Mexico 87504-2108
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   1-800-274-4212

   Instrument Repair and Calibration
   Eberline Instrument Corporation
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   West Columbia, South Carolina 29169
   Telephone: (803)796-3604
   1-800-234-4212

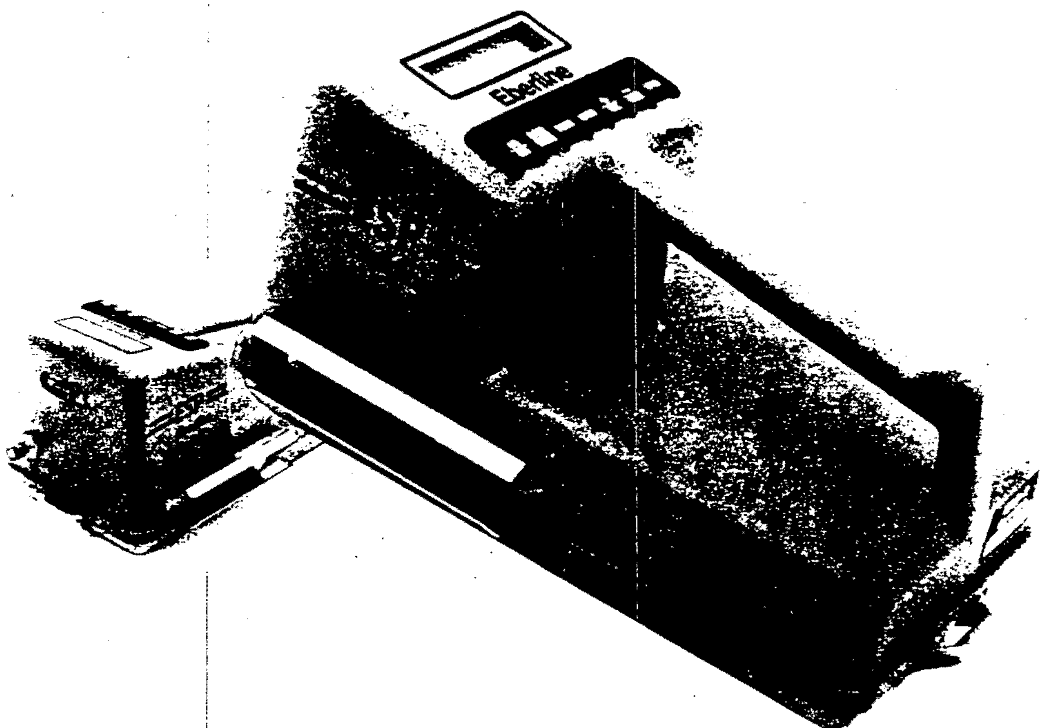
4. In addition, the following Customer Service Center is available for customers outside the United States:

   Thermo Electron, Ltd.
   Woolborough Lane
   Crawley, West Sussex
   England, RH10 2AQ

Prices at this location will vary from U.S. prices. Please contact the facility for current price and delivery information.

December 1987

Eberline Smart Portable Model ESP-2



- DATA LOGGING MICROCOMPUTER-BASED SURVEY INSTRUMENT WHICH STORES SURVEY READINGS FOR LATER OUTPUT TO A PRINTER OR PERSONAL COMPUTER
- OPERATES WITH VIRTUALLY ALL EBERLINE DETECTORS TO MEASURE ALPHA, BETA, GAMMA, X-RAY AND NEUTRON RADIATION
- AUTOMATICALLY SETS PROPER HIGH VOLTAGE, CALIBRATION CONSTANT AND DEAD TIME WHEN THE USER SPECIFIES THE DETECTOR CONNECTED TO IT
- OFFERS EXTENDED RANGE WITH AUTOMATIC DEAD TIME CORRECTION
- OPTIONAL PULSE HEIGHT ANALYSIS (PHA) CAPABILITY AVAILABLE FOR MULTIPLE ISOTOPE DISCRIMINATION
- FUNCTIONS AS A RATEMETER OR SCALER

Model ESP-2, Eberline Smart Portable

GENERAL DESCRIPTION

The Eberline Smart Portable, Model ESP-2, offers a significant advancement over currently available survey instruments. It incorporates a microcomputer with storage capability for approximately 500 separately identifiable data points. Data can be transferred to a personal computer, or to a printer to produce hard copy, via an RS-232C serial interface port. For the many users who make large numbers of routine surveys, the ESP-2 will provide significant savings of manpower as well as accuracy of data transfer.

Any data transferred to a personal computer will include number, detector, user identification, operating mode, instrument calibration settings and instrument operating status. Thus, a hard copy record is available for regulatory or legal records of instrument operating conditions during the survey. This should be especially useful for radiation safety offices, health physics departments, nuclear medicine departments, research laboratories, or any application where hard copy records are needed.

The ESP-2 is designed for use with GM, scintillation and proportional detectors with which it is capable of measuring alpha, beta, gamma, x-ray and neutron radiation. It can function as a ratemeter or scaler and displays appropriate radiation units along with the data. Ratemeter readings are displayed in both digital and analog (bar graph) format to overcome trend-indicating problems of other digital instruments. Microcomputer-based, the ESP-2 corrects for coincidence loss so that the upper limit of the range of each detector is increased by a factor of ten or more. Single-channel pulse height analysis (PHA) capability is also available (optional).

Inventory savings can be significant by using the ESP-2. This instrument will perform the functions of many other radiation survey instruments when coupled with detector probes available as accessories. One detector probe can be used to measure gamma exposure, another to measure beta contamination and another to measure neutron dose equivalent. With appropriate detectors, the ESP-2 can replace virtually all of Eberline's portable ratemeters and scalers.

Ease of operation is another reason for using the ESP-2. Parameters can be pre-set for three different detectors and by menu selection the ESP-2 will automatically adjust to the high voltage and calibration parameters as pre-selected for the detectors chosen. The high voltage adjustment is placed under computer control: thus, the high voltage can actually be changed via the keypad. Once the instrument has been calibrated to three different detector probes, keypad access can be denied to any user who does not know the password. Thus, the instrument operator can use three different detectors without any fear that he may accidentally change an important parameter.

SPECIFICATIONS

INTERNAL CONTROLS

Internal adjustment controls, located behind a splash-proof door on the right side of the ESP-2, include the following:

1) discriminator (sensitivity variable from 0.75 to 15 mV)
2) display viewing angle
3) detector pulse rate to speaker (scale ratios of 1:1, 1:64, 1:256)

EXTERNAL CONTROLS

All external controls are on a single row of seven momentary push-button switches. The switches are 3/8-inch square buttons on ½-inch centers. Functions controlled are: "ON/OFF," "MODE/STORE," "RESET," "LIGHT," "+," "-" and "SPKR."

OPERATING MODES

Ratemeter Mode

In the ratemeter mode, the microcomputer calculates counts per second, divides by the calibration factor and displays the digital value along with the appropriate units selected. Count rate is also displayed on a bar graph (analog), the length of which is proportional to the detector count rate. If the bar graph goes off-scale, the operator can adjust the scale with one push of the "RESET" button.

When the alarm level is exceeded, an alarm is sounded (2000 Hz tone) on the speaker. This is sounded even if the built-in speaker is turned off. Pressing the SPKR button acknowledges the alarm and turns it off.

Another feature available in the ratemeter mode of operation is the "peak trap" function. When operating in this mode, pressing the "STORE" key causes the maximum reading to be stored in memory. If peak mode has not been selected, pressing "STORE" simply causes the current reading to be stored in memory.

Scaler Mode

In the scaler mode, the detector signal is integrated for the selected count time (one second to four hours). Time remaining is displayed on the top line. Integrated value and units of readout are displayed on the bottom line. For example, if the HP-270 probe is used, integrated exposure in mR can be displayed. Similarly, dis/min can be displayed for the HP-210T or HP-260 probe.

When integrated counts exceed the selected alarm setting, the alarm sounds. This feature can be used to tell a work party when to leave a radiation area.

An automatic store mode ("autorecycle function") is available in conjunction with the scaler mode. At the completion of the count cycle, the results are logged to memory and the cycle re-started. This feature can be used with a radon gas detector to function as a continuous radon gas monitor. Many other similar applications are possible.

Another function is provided under scaler mode which allows the user to program the scaler to count until a pre-set number of events have occurred (and thus a fixed statistical accuracy attained). This mode can be used with either the manual or automatic store modes.

Inquiry/Calibration Mode

Five different access levels are available with the ESP-2 and can be used to prevent unauthorized users from changing parameters which affect calibration and operation. The user can be limited to storing data points only, to selecting detectors, to setting the clock, or being able to change baud rate and calibration constants. All access levels where parameters can be changed are capable of being under password protection via the keypad.

Operating parameters that may be selected in the inquiry/calibration mode include units, calibration factor, detector dead time, alarm setting, operating mode, detector select and detector high voltage.

When the ESP-2 is being calibrated, any combination of the following readout units may be selected.

Prefix	Base Unit	Time Unit
none	R	s
u	rem	min
m	Sv	h
k	Gy	
auto	Cnt	
	dis	Example: mR/h
	rad	

By selecting the auto prefix in the menu, the detector readings are displayed in floating point (non-scientific notation) format with the prefix automatically adjusting to keep the reading within the three digit range. Depending on the calibration, this could allow as many as twelve decades of readout without going to scientific notation.

DATA LOGGING FEATURES

Data can be logged to memory in the ESP-2. The storage capacity, 8k bytes of random access memory (RAM), is approximately 500 points. Each point can be defined with a set of parameters to make it a unique data entry.

A routine is provided to allow the user to enter parameters which will be tied to all subsequent data. A nine digit numeric code can be entered to identify the user, such as a social security number. A six digit numeric code can be entered to identify the instrument. A thirteen digit alphanumeric code is used to identify the detector being utilized. An example of this could be: HP260 s/n 943.

The data logging mode requires the user to press the "STORE" key in order to log a data point to memory. This can be done in either the ratemeter or the scaler mode. The value stored is tied to the current date/time, through the use of an on-board real-time clock, as well as the current location code, which can be changed at any time by the user changing one or more digits of a six digit identifier. If the user does not enter a new identifier, the ESP-2 will automatically increment the location code.

Associated with the automatic store function under the scaler mode is the ability to output each data point to the peripheral in addition to storing it in memory after the cycle is completed (in strip chart fashion).

An RS-232C port is configured for use on the ESP-2. This port is flexible enough to meet a variety of needs. All transmissions are in ASCII notation eliminating the need for decoding software in the peripheral device. Standard baud rates from 150 to 9600 can be set through the keyboard.

A typical printout might look something like the following:

```
JUN 15, 86 1230
INSTRUMENT #                          000000
USER I.D. #                        000000000
DET: #1
MODE: RATEMETER
CALIB. CONSTANT                   1.00E + 00
DEAD TIME (SEC)                    9.98E-07
HIGH VOLTAGE                      5.00E + 02
                        LOC.    cnt/min    STAT
06/15/86  1230        000000  3.96E + 03
06/15/86  1230        000001  3.93E + 03
```

BATTERY

Six standard alkaline "C" cell batteries provide approximately 300 hours continuous use (excluding display lighting). The ESP-2 senses low battery condition at 0.95 V/cell and signals to the operator by blinking the first character on the display. After low battery is first detected, at least four hours of use remains. An internal capacitor is used to supply power to the computer and prevent loss of calibration parameters for about 20 minutes while the batteries are being changed.

Non-volatile memory data is retained even after the ESP-2 is turned off. Battery drain with power off is negligible.

As a protective feature, the battery compartment is separated from other internal components.

OTHER SPECIFICATIONS

Dimensions: 5.0 inches high × 5.0 inches wide × 10.25 inches long (12.7 cm × 12.7 cm × 26.0 cm)
Temperature Range: -4°F to +122°F (-20°C to +50°C)

Weight: 4.1 pounds (1.86 kg)
Connectors: MHV for detector input. 9-pin "D" shell female connector for RS-232C communication

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DETECTOR PROBES RECOMMENDED FOR USE WITH ESP-2

Model No.	Type Measurement	Useful Range with ESP-2	5 Percent*
HP-270	Exposure or Exposure Rate	Bkg to 3000 mR/h	1 to 3000 mR/h
HP-290	Exposure or Exposure Rate	0.0005 to 80 R/h	0.01 to 80 R/h
HP-210L HP-260	Beta-Gamma Contamination	Bkg to 100,000 counts/s	14 to 100,000 counts/s
AC-3	Alpha Contamination	Bkg to 50,000 counts/s	14 to 50,000 counts/s
NRD	Neutron Dose Equivalent or Dose Equivalent Rate	0.001 to 60 rem/h	0.02 to 60 rem/h
LEG-1	Low Energy Gamma or x-ray	Bkg to 50,000 counts/s	14 to 50,000 counts/s
SPA-3	High Sensitivity Gamma	Bkg to 50,000 counts/s	14 to 50,000 counts/s
SPA-6	Medium Sensitivity Gamma	Bkg to 50,000 counts/s	14 to 50,000 counts/s

*Ratemeter mode provides 5 percent, or better, standard deviation readout capability over the indicated range.

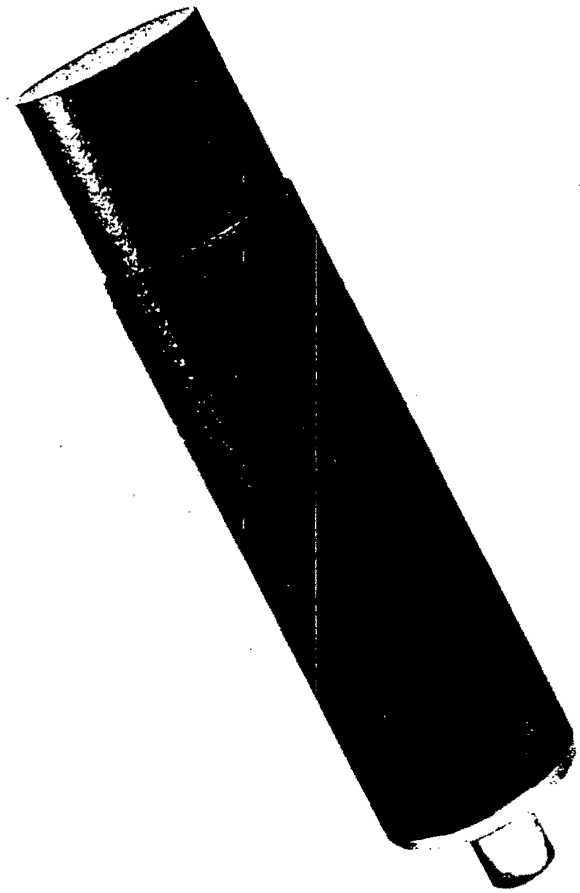
ACCESSORIES

Audio Headset: Part No. ADHS4

Any of the following Eberline detectors can be used with the ESP-2:

Detector Probe	Cable	Check Sources	Probe Holder/Bracket
AC-3	CA-12-60	CS-1, CS-10, CS-12, CS-15	
HP-190A	CA-16-60	CS-7A	ZP10434029
HP-210AL	CA-16-60	CS-13	
HP-210L	CA-16-60	CS-13	
HP-210T	CA-16-60	CS-13	
HP-220A	CA-16-60		
HP-260	CA-16-60	CS-13	ZP10434029
HP-270	CA-16-60	CS-7A	ZP10434029
HP-280	CA-15-36		
HP-290	CA-16-60		ZP10434029
LEG-1	CA-12-60		
NRD	CA-15-60		ZP11292020
PG-2	CA-12-60		
SPA-3	CA-12-60	CS-7B	ZP10465017
SPA-6	CA-15-36	CS-7B	ZP10465017
SPA-8	CA-15-36	CS-7B	
SPA-9	CA-15-36	CS-7B	ZP10465017

Scintillation Probe Model SPA-3



- HIGH GAMMA SENSITIVITY
- 2-INCH × 2-INCH NaI (Tl) CRYSTAL
- RUGGED CONSTRUCTION

Eberline A subsidiary of Thermo Instrument Systems Inc.

SPA-3

Model SPA-3, Scintillation Probe

GENERAL DESCRIPTION

The Model SPA-3 scintillation probe is a rugged, waterproof gamma detector designed for high sensitivity of pulse-height applications.

The SPA-3 contains a 2-inch-diameter, 2-inch-long NaI(Tl) crystal, a 2-inch, 10-stage photomultiplier tube, tube socket with a dynode resistor string, and a magnetic shield.

SPECIFICATIONS

Crystal: NaI(Tl), 2-inch-diameter × 2 inches long (5.1 cm × 5.1 cm).

Photomultiplier Tube: ≅2-inch-diameter, 10-dynode, end-window with S-11 photocathode.

Operating Voltage: Variable dependent upon application.

Maximum Voltage: + 1600 V

Sensitivity: ≅1200k cpm per mR/h with ^{137}Cs

Current Drain: ≅120 MΩ resistance string yields 10 μA at 1200 V.

Wall Material: Aluminum

Wall Thickness: 1/8-inch (0.32 cm), 1/16-inch (0.16 cm) at crystal

Connector: Mates with Eberline CP-1

Finish: Enameled body with chrome-plated connector

Size: 2 5/8-inch-diameter × 11 1/8 inches long (6.7 cm × 28.3 cm)

Weight: 3.25 pounds (1.5 kg)

AVAILABLE ACCESSORIES

Instruments	Cables
ASP-1	CA-12-60
ESP-1	CA-12-60
ESP-2	CA-12-60
ESP-2/PHA	CA-12-60
MS-2	CA-12-60
RM-20	CA-12-60
RM-21	CA-12-60
RM-23	CA-12-60
SAM-2	CA-12-60
SRM-100	CA-12-60
SRM-200	CA-12-60
SRM-200PHA	CA-12-60

Eberline
A subsidiary of Thermo Instrument Systems Inc.

P.O. Box 2108
Santa Fe, New Mexico 87504-2108
(505) 471-3232   TLX: 66-0438 EIC SFE
Telecopy: (505) 473-9221

Model SPA-3, Scintillation Probe

GENERAL DESCRIPTION

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The SPA-3 contains a 2-inch-diameter, 2-inch-long NaI(Tl) crystal, a 2-inch, 10-stage photomultiplier tube, tube socket with a dynode resistor string, and a magnetic shield.

SPECIFICATIONS

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ESP-2/PHA	CA-12-60
MS-2	CA-12-60
RM-20	CA-12-60
RM-21	CA-12-60
RM-23	CA-12-60
SAM-2	CA-12-60
SRM-100	CA-12-60
SRM-200	CA-12-60
SRM-200PHA	CA-12-60

Eberline
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Telecopy: (505) 473-9221

REFERENCE # 16

NAVAJO SUPERFUND OFFICE

BROWN VANDEVER URANIUM MINE REFERENCE MATERIAL

MAY, '90 P. MOLLOY

CONTACT REPORT

Meeting: ( ) **Telephone:** (x) **Other:** ( )

CONTACT LOCATION: NAVAJO SUPERFUND OFFICE

ADDRESS: P. O. BOX 2946, WINDOW ROCK, AZ 86515

PERSON CONTACTED AND TITLE : MIKE HOLONA, RANGER, NAVAJO FISH AND WILDLIFE

PHONE: (602) 871 - 1452

FROM (Contacting Party) : PATRICK ~~MOLLOY~~, HEALTH PHYSICIST, NAVAJO SUPERFUND OFFICE

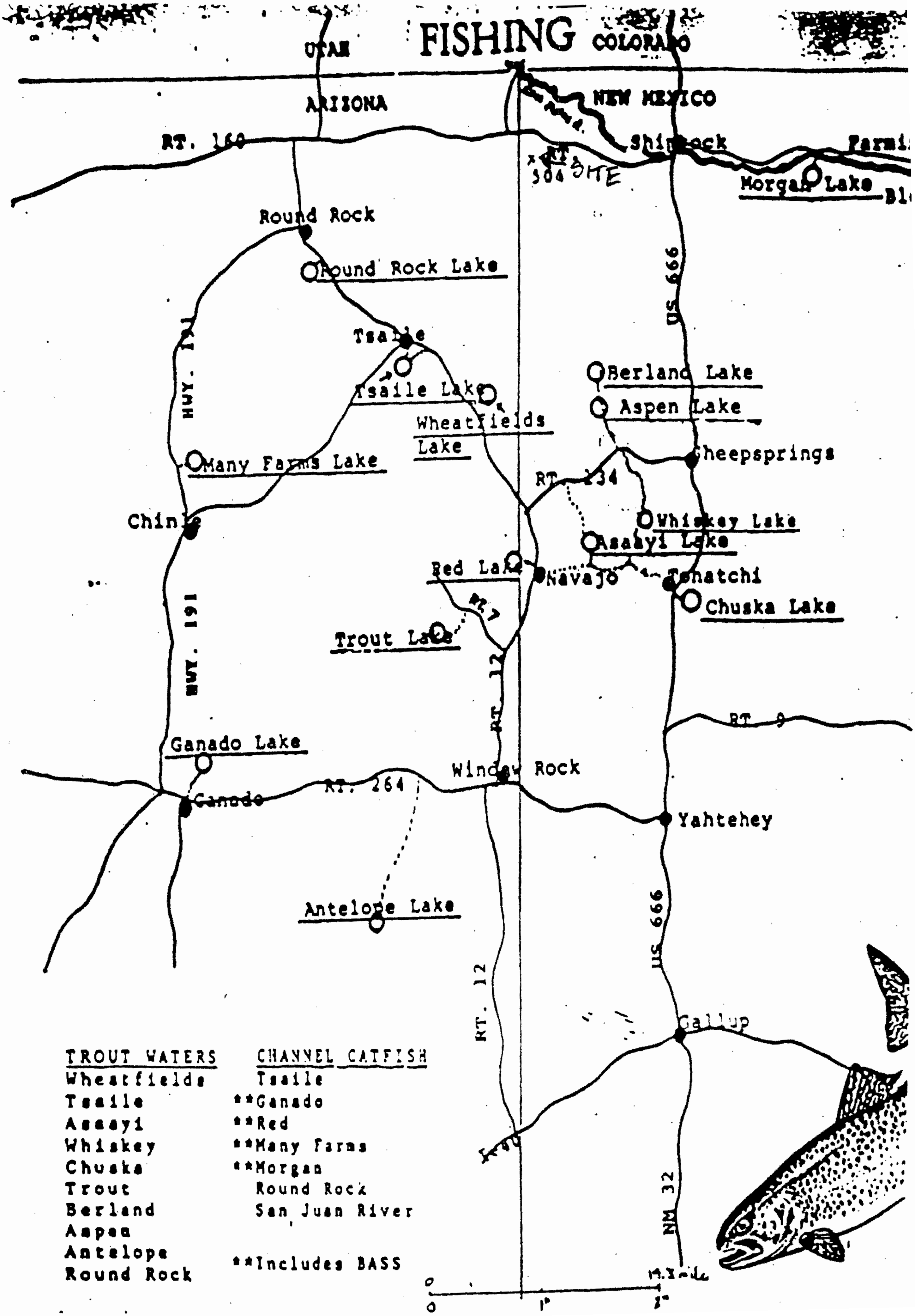
DATE : MAY 10,1990

SUBJECT: FISHERIES, HUNT UNITS AND RECREATIONAL AREAS IN HAYSTACK MOUNTAIN AREA

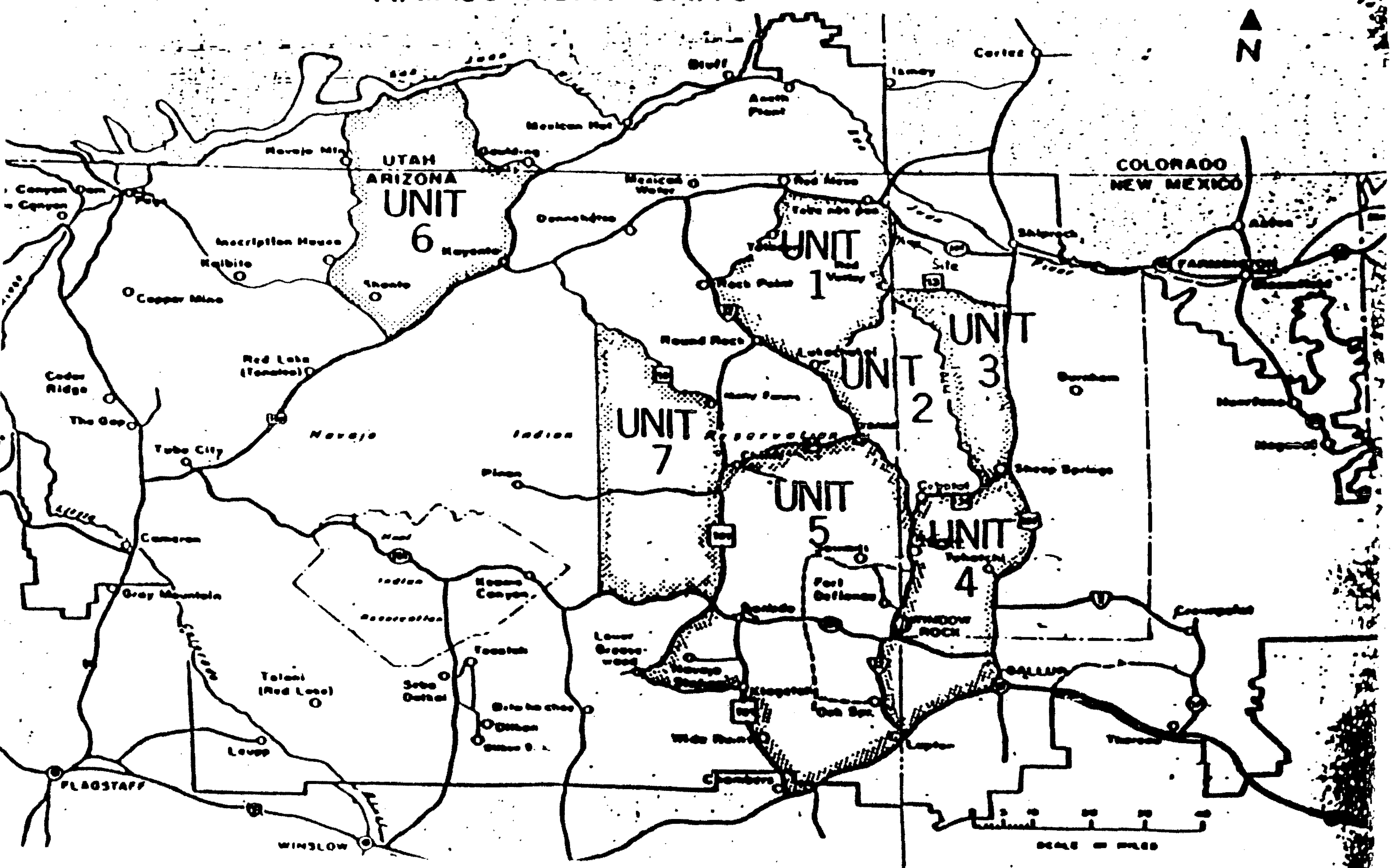
CONTACT SUMMARY REPORT:

(1) THERE ARE NO FISHERIES IN THE HAYSTACK MOUNTAIN AREA

(2) THERE ARE NO NAVAJO HUNT UNITS OR OTHER DESIGNATED RECREATIONAL AREAS IN THE HAYSTACK MOUNTAIN AREA


FISHING
UTAH
COLORADO
ARIZONA
NEW MEXICO
RT. 160
Shiprock
RT. 504
SITE
Morgan Lake
Round Rock
Round Rock Lake
US 666
Tsaile
Tsaile Lake
Berland Lake
Aspen Lake
Wheatfields Lake
HWY. 191
Many Farms Lake
Sheepsprings
RT 134
Chinle
Whiskey Lake
Asaayi Lake
Red Lake
Navajo
Tohatchi
Chuska Lake
RT 7
Trout Lake
RT. 12
RT. 9
Ganado Lake
Window Rock
RT. 264
Ganado
Yahtehey
Antelope Lake
Gallup
NM 32
TROUT WATERS
Wheatfields
Tsaile
Asaayi
Whiskey
Chuska
Trout
Berland
Aspen
Antelope
Round Rock
CHANNEL CATFISH
Tsaile
**Ganado
**Red
**Many Farms
**Morgan
Round Rock
San Juan River
**Includes BASS
0
1"
2"

NAVAJO HUNT UNITS



REFERENCE # 17

NAVAJO SUPERFUND OFFICE

BROWN VANDEVER URANIUM MINE REFERENCE MATERIAL

MAY, '90 P. MOLLOY

CONTACT REPORT

Meeting: ( ) Telephone: (X) Other: ( )

Contact Location: Navajo Nation Minerals Department

Address: P.O. Box 308, Window Rock, Arizoona 86515

Person, Title, Contacted: Rich Koch, Geologist

From: Pat Molloy PCM

Date: April 18, 1989

Subject: Leases - Navajo Lands Uranium Mines

Contact Summary Report:

Pre 1960's Uranium Mines -- no records now with tribe. All leases for mines worked before 1960 are presume to be expired.

Minerals department not existence until late 60's. No documents or records on these mines indicating lease holders are in existence with this department.